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NUCLEAR SCIENCE ABSTRACTS

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Index References

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FOURRIER, Alain
  Radioactive chain of mass number 189,  21:10023
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Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

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MONTH, M.
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    10899)
MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
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Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

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SHEEP
  radiation dosimetry in, measurement of lethal dose of x,
    21:8905(R) (AD-631189)
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  evaluation of fallout, for fire and air blast damage,
    21:8560 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
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Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

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UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
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    2)
  22298        21-9915   Nucl. News, 9: No. 12, 17-21 (Dec.
                           1966)
  22298        21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                           1967)
  23267        21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
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  23420        21-8764   Lancet, 2: 672-5(Sept. 24, 1966)
  23474        21-8528   Dep. mn. CFSTI $3.00 cy, $0.65 mn
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  23482        21-9471   Dep. mn. CFSTI $3.00 cy, $0.65 mn
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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 12404, 12827, and 12864.

12222 (AWRE-O-59/61) TRITIUM COUNTING BY OBSERVATION OF X-RAYS. James, R. H.; Ellis, P.; Brown, F. (Atomic Weapons Research Establishment, Aldermaston (England)). Nov. 1961. 23p. Dep. CFSTI. UK.

A method was devised for determining tritium by observation of the L x-ray emitted from a thin film of gold. This method should provide a means of counting tritium in any static or dynamic system without removal of a sample of the gas and without addition of any other gas. A lower limit of detection of 10 μc or 5 ppM tritium in hydrogen should be attainable. (auth) (UK)

12223 (NAA-SR-12616) SAMPLING BLANKS FOR THE LMFBR CLADDING PROGRAM. Murbach, E. W. (Atomics International, Canoga Park, Calif.). Jan. 30, 1968. Contract AT(04-3)-701. 18p. Dep. CFSTI.

An investigation of the blanks associated with sampling of loops and retorts in use on the LMFBR Cladding Program was carried out. The blank for the flow-through samplers used on loops was determined by treating pieces of tubing with amalgam prepared from low-oxygen sodium and measuring the increase in oxygen content of the amalgam. The blank for stainless steel tubing is 3.2 ± 0.8 ppM oxygen, and for nickel tubing is 2.0 ± 1.0 ppM oxygen. The blank for the retort sampler was determined by sampling the supply loop simultaneously with a flow-through and retort sampler. This blank was found to be 7.4 ± 1.5 ppM oxygen. (auth)

12224 (NP-17239) ANALYSIS OF ORGANIC COOLANTS. Geiss, F.; Laurent, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 1966. 24p. Dep.

Analysis of terphenyl reactor coolants is discussed. Gas-chromatographic techniques are considered. The molecular weight profile for characterization of high boilers is described and results are evaluated. Methods for determining oxygen, chlorine, sulfur, iron, and boron in the organic coolant are discussed. (M.C.G.)

12225 (ORNL-4135) DESIGN AND EVALUATION OF A DELAYED-NEUTRON LEACHED-HULL MONITOR. Strain, J. E.; Ross, W. J.; West, G. A.; Landry, J. W. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 42p. Dep. CFSTI.

A delayed-neutron leached-hull monitor was developed. It is capable of detecting as little as 10 mg of ^{235}U in the presence of a gamma field of 10^5 R/hr. The instrument is intended for use in the Shear-Leach process for recovering spent fuel. Two prototype monitors were constructed and evaluated; one was designed for semicontinuous automatic operation, and the other was designed to analyze directly the 20-cm-dia by 150-cm-long dissolver baskets. Results of the analysis are independent of cladding material, burnup, or cooling time, and appear as simple ratios of neutron counts. The method is, therefore, readily adaptable to automation or to operation by nontechnical personnel. (auth)

12226 (UCRL-17866) DEVELOPMENT OF A HIGH PRESSURE MASS SPECTROMETRIC GAS ANALYSIS SYSTEM. Waddel, William W. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1967. Contract W-7405-eng-48. 41p. Dep. CFSTI.

Thesis.

A relatively high pressure gas analysis system utilizing a quadrupole mass spectrometer has been developed. The gas to be sampled is contained at pressures up to 20 torr in an inlet tube from which a molecular beam issues through a small orifice. The molecular beam is collimated and directed through the ionizer of the spectrometer. By employing differential pumping, a modulated molecular beam, and a narrow band phase sensitive lock-in amplifier, a partial pressure of 9×10^{-13} torr was detected in a beam with an equivalent pressure of 6×10^{-7} torr (1.5 ppM). Based on the signal-to-noise ratio it was estimated that the minimum partial pressure that could be detected in this beam is about 6×10^{-14} torr (0.1 ppM). Two different types of noise averaging devices were employed, a narrow band lock-in amplifier and an analog-to-digital computer. The molecular isotopes of oxygen were studied to determine the sensitivity of the system. Known mixtures of methane in hydrogen were also analyzed and the cracking pattern of these species is reported. Two distinct advantages of this system are the ability to work at relatively high source pressures and the insensitivity of the method to background gases in the vacuum chamber, whose contribution to the mass spectrum is effectively suppressed by the phase-sensitive detection technique. (auth)

12227 (AD-662383) RADIOACTIVATION ANALYSIS OF SILICON DIOXIDE USING ION-EXCHANGE CHROMATOGRAPHY. Kalinin, A. I.; Kuznetsov, R. A.; Moiseev, V. V.; Sepurnieks, V. E. Translated from Radiokhim. Metody. Opred. Mikroelem., Akad. Nauk SSSR, Sb. Statei, 161-7(1965). 12p. (FTD-MT-66-142; TT-7500425). CFSTI.

This article was previously abstracted in NSA as 20: 20632. (P.C.H.)

12228 (BNWL-tr-24) DETERMINATION OF PLUTONIUM IN PLUTONIUM-ALUMINUM ALLOYS BY X-RAY FLUORESCENCE. Ganivet, M.; Arnal, Th. Translated by E. R. Appleby (Battelle-Northwest, Pacific Northwest Lab., Richland, Wash.), from Anal. Chim. Acta, 39: 73-9(1967). 10p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

An abstract prepared from the original of this paper appeared as NSA 21: 34231. (auth)

12229 (MLM-1472(tr)) APPLICATION OF GAS CHROMATOGRAPHY TO THE EXTRACTION OF INERT GASES. Gnauck, G. Translated for Mound Lab., Miamisburg, Ohio, from Instrum. Meas., Chem. Anal., Elec. Quant., Nucl. Process Contr., Proc., Int. Conf., 5th, Stockholm, 1960, 1: 435-46(1961). 18p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

This paper was previously abstracted for NSA from the original language and the abstract appeared as 17: 10954. (M.C.G.)

12230 USE OF ACTIVATION ANALYSIS IN PROBLEMS OF DRUG CONTROL. Reynolds, Leon M. (Ball State Univ., Muncie, Ind.); Kessler, Wayne V.; Christian, John E.; Ziemer, Paul L. J. Pharm. Sci., 56: 437-43(Apr. 1967).

Methods are described for using neutron activation analysis (NAA) to detect counterfeit drugs and the diversion of legitimate drugs into illegal underground channels of distribution. Use of NAA was investigated for identification of the source of a drug product by analysis of certain trace elements added to it during manufacture, or by analysis of natural trace elements or contaminants already present. A table is given of the abundance, activation cross-section, half life, γ-ray yield/disintegration, peak energy and sensitivity of the technique for the following possible

identifying markers: ^{55}Mn, ^{63}Cu, ^{75}As, ^{121}Sb, ^{127}I, ^{138}Ba, ^{139}La, ^{151}Eu, ^{152}Sm, ^{164}Dy, ^{174}Yb, ^{175}Lu, ^{179}Hf, ^{187}Re, and ^{197}Au. Samples for irradiation were prepared in the form of fine, dry powders sealed in plastic containers. Stock mixes of seven additives in lactose were prepared in concentrations ranging from 0.01% for Dy_2O_3 to 2% for La_2O_3. For the investigation of the scheme of additives, a reactor with an available flux of about 2×10^{10} thermal neutrons/cm^2/sec was used. Studies on natural contaminants were carried out, using a flux of about 5×10^{12}, in the CP-5 reactor at Argonne National Lab. Counting was begun as soon as possible after removal from the reactor (about 1 hr for the first reactor and 3 hr for the CP-5). Counting was delayed one week after the longer irradiation, to permit decay of the ^{24}Na. Contaminants observed in dextroamphetamine sulfate tablets and capsules are shown. Spectra of tablets from four different manufacturing sources, taken after a 30-min irradiation and a 6-hr waiting period, showed the presence of only ^{24}Na, ^{56}Mn, and ^{87m}Sr, but in widely varying amounts. Six dextroamphetamine sulfate products from different manufacturers were found to be clearly and readily distinguishable from each other, on the basis of contaminants present and their relative concentrations. (BBB)

12231 ISOTOPIC ANALYSIS OF RHENIUM FROM A THERMAL IONIZATION SOURCE. Riley, G. H. (Southwest Center for Advanced Studies, Dallas). J. Sci. Instrum., 44: 769-74 (Sept. 1967).

Problems associated with thermal ionization of elements of high ionization potential are reviewed. The development and performance of a simple control circuit for pulse counting ion beams in a commercial 12-in. 90° mass spectrometer is discussed, and an assessment of the errors involved in this mode of analysis is made. Past measurements of the isotopic abundance of natural rhenium are compared with the results. The ratio $^{185}Re/^{187}Re$ obtained is approximately 1.5% greater than the current value preferred in the literature. Mass discrimination introduced by electron multipliers used in current integration and pulse counting modes is discussed. A mass-dependent multiplier correction is indicated from the results of this study. (auth) (UK)

12232 DETERMINATION OF THE CONCENTRATION OF ^{15}N IN NO_3^- ION BY INFRARED SPECTROMETRY. Knezevic, Z. V. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Isotopenpraxis, 3: 452-3(1967).

A method of determining the content of ^{15}N in KNO_3 using an infrared spectrophotometer is described. A ν_2 band of NO_3^- ion dissolved in potassium bromide was used for the measurement. The precision of measurement was 0.6 percentage units at the 95% probability level. (auth)

12233 THE EXPERIMENTAL TECHNIQUE OF THE NEUTRON ABSORPTIOMETRIC TITRATIONS. Dillinger, P.; Tolgyessy, J.; Varga, S. Isotopenpraxis, 3: 437-40(1967). (In Russian).

The principles of using interaction of neutron radiation with the analysis samples for indication of the end-point are described (neutron absorptiometric titrations). The construction schemes of the equipment for titrations by precipitation and extraction are given along with the procedure for these titrations. (auth)

12234 DETERMINATION OF ^3H AND ^{85}Kr IN AQUEOUS SAMPLES BY LIQUID SCINTILLATION TECHNIQUES. Cohen, J. B.; Setser, J. L.; Kelley, W. D.; Shearer, S. D. Jr. (Taft Sanitary Engineering Center, Cincinnati). Talanta, 15: 233-9(Feb. 1968).

Analytical procedures were developed for the simultaneous determination of tritium and krypton-85 tracers in aqueous solutions by liquid scintillation techniques. The effects of sample size, amount of water, and dyestuff used as water tracer were investigated. (auth) (UK)

12235 DEPENDENCE OF ^{90}Sr IN MILK ON ITS CONCENTRATIONS IN AIR AND SURFACE DEPOSITION. Lalit, B. Y. (Bhabha Atomic Research Centre, Bombay). J. Sci. Ind. Res., 26: 372-5(Sept. 1967).

Regression analysis was carried out to find the dependence of the ^{90}Sr content of milk on its concentration in air, its monthly rate of deposition, and cumulative deposition in soil at Bombay. This analysis showed that the dependence of ^{90}Sr in milk on its concentration in air is important, especially in areas like Bombay where the major deposition on the ground takes place only during four months of the rainy season. The collection in the dry season on the foliage is mainly by impaction of airborne ^{90}Sr. A comparison was made between the measured levels of ^{90}Sr in milk and levels calculated from concentration in air, monthly deposition, and cumulative deposition using net regression coefficients obtained from the data for eight years. Good agreement is obtained when the year is divided in two parts, viz. the dry months from December to May and rainy period from June to November; and average concentrations for these periods are used for the calculation of ^{90}Sr in milk from regression equations. The values so estimated agreed to within 30% with the values measured experimentally. (auth)

12236 DETERMINATION OF OXYGEN IN ZIRCONIUM, MOLYBDENUM, HAFNIUM, AND TUNGSTEN BY IRRADIATION WITH ^{3} ^4He. Revel, Gilles; Albert, Philippe (Centre d'Etudes de Chimie Metallurgique, Vitry-sur-Seine, France). Compt. Rend., Ser. C, 265: 1443-6(Dec. 18, 1967). (In French).

For the metals studied, irradiation by a beam of ^3He ions permitted the determination of oxygen and the definition of an upper limit of the concentration of carbon. The possibilities of determining oxygen in zirconium by irradiation with ^4He were also studied. (tr-auth)

12237 VOLUMETRIC DETERMINATION OF THE U/O RATIO IN URANIUM OXIDES. Engelsman, J. J.; Knaape, J.; Visser, J. (Phillips Research Labs., Eindhoven, Netherlands). Talanta, 15: 171-6(Feb. 1968).

A method is given for determining the general formula UO_{2+x} of sintered uranium dioxide pellets and uranium dioxide powders. Uranium(VI) is reduced by titration with iron(II) ammonium sulphate, after which the total amount of uranium is oxidized by titration with potassium dichromate. The end-points of both titrations are detected electrometrically. Determination of x in the range 0.0001 to 1.00 is possible. (auth) (UK)

12238 GAMMA SPECTROMETRY FOR MEASUREMENT OF LOW LEVEL RADIOACTIVITY WITH SPECIAL REFERENCE TO ^{131}I IN WATER. Collins, J. C. (Univ. of Manchester, Eng.); Joseph, J. D.; Atkinson, J. W. Proc. Soc. Water Treat Exam., 16: 268-86(1967).

The investigation described showed that the detection and determination of iodine-131 in drinking water can be carried out directly by gamma spectrometry using 1 litre samples containing iodide carrier. A cylindrical sodium iodide thallium-activated crystal 4 in. deep by 4 in. diameter coupled to a 5 in. diameter photomultiplier tube was employed. The thresholds of detection with 1 hour and 3 hours counting times are around 50 and 25 pCi/l, respectively, and a concentration of 50 pCi/l of iodine-131 can be determined with sufficient precision (coefficient of variation 19%) in the relatively short counting time of 3 hours. The method could be extended to cover the detection and determination of other radioisotopes in water in an emergency. (auth) (UK)

12239 POLAROGRAPHY OF MOLYBDENUM IN ASPARTIC ACID SOLUTION. Gupta, C. M.; Gupta, J. K. (Univ. of Rajasthan, Jaipur, India). Talanta, 15: 274-6(Feb. 1968).

The polarographic behaviour of Mo(VI) in solutions of aspartic acid is reported. In 0.01M acid, two waves are obtained, but at pH 4 only one, and these are diffusion controlled. Determination is possible in the presence of Ni, Cr(VI), W(VI), Mn(II), Co(II), Cu(II), or Th, with an accuracy of 2% in the range 10^{-5} to 10^{-3}M. (auth) (UK)

12240 NEUTRON ACTIVATION ANALYSIS BY STANDARD ADDITION AND SOLVENT EXTRACTION. DETERMINATION OF IMPURITIES IN THORIUM AND IRON. Alian, A.; Shabana, R. (Atomic Energy Establishment, Cairo). Talanta, 15: 257-61(Feb. 1968).

It was found that the neutron activation analysis of trace impurities in thorium nitrate and in iron is facilitated by solvent extraction procedures prior to counting. (auth) (UK)

12241 NEUTRON-ACTIVATION ANALYSIS BY STANDARD ADDITION AND SOLVENT EXTRACTION. DETERMINATION OF TRACES OF ANTIMONY. Alian, A.; Shabana, R.; Sanad, W.; Allam, B.; Khalifa, K. (Atomic Energy Establishment, Cairo). Talanta, 15: 262-6(Feb. 1968).

The application of neutron activation analysis by standard addition and solvent extraction to the determination of traces of antimony in aluminium and rocks is reported. Three simple extraction procedures, using isopropyl ether, hexone, and tributyl phosphate, are described for the selective separation of radioantimony from interfering radionuclides. Antimony concentration is measured by counting the activities of the ^{122}Sb and ^{124}Sb photopeaks at 0.564 and 0.603 MeV, respectively. (auth) (UK)

12242 ACTIVATION ANALYSIS OF TRACE CONTAMINANTS IN GaAs SEMICONDUCTOR MATERIALS. Szabo, E.; Rausch, H. (Central Research Inst. for Physics, Budapest, Research Inst. for Telecommunication, Budapest). Acta Chim. Acad. Sci. Hung., 54: 231-40(1967).

A rapid activation method for the determination of copper in GaAs monocrystals is described. The contaminant activities are separated from the activities produced in the matrix elements by remote controlled extraction. The use of dithizone as a group reagent makes possible the determination of five other contaminants (Au, Hg, Cd, Zn, Co) simultaneously with copper. The contaminants are identified by their gamma spectra with coincidence technique. The method is faster and less laborious than conventional multistep chemical separation. The extraction and measurement of the six contaminants under investigation can be performed in about 4 to 6 hours. (auth)

12243 USE OF GAMMA SPECTROMETRY FOR THE DETERMINATION OF GOLD IN NATIVE GOLD-BEARING MINERALS BY RADIOACTIVATION BY THERMAL NEUTRONS. Pascu, N. (Institut de Chimie de l'Academie, Cluj). Rev. Roum. Chim., 12: 1123-6(Sept. 1967). (In French).

Gold was determined in native gold-containing minerals after neutron activation by gamma scintillation spectrometry by using the comparative method and selective and quantitative extraction of the gold with isoamyl alcohol in a 0.1M hydrochloric acid medium. (tr-auth)

12244 ANALYSIS OF NEODBYMIUM–TELLURIUM ALLOYS. Sklyarenko, Yu. S.; Nazarenko, I. I.; Razgon, E. S. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 23: 91-5(Jan. 1968). (In Russian).

The following methods were tested for determination of neodymium and tellurium in Nd–Te alloys: tellurium was determined by weighing it as elemental tellurium and as TeO_2 and neodymium was determined by weighing it as Nd_2O_3 and by means of a complexonometric method. The combination of the gravimetric method for determining tellurium as TeO_2 with the complexonometric method for determining the rare earth element is suggested as the most suitable. (auth)

12245 SPECTROGRAPHIC DETERMINATION OF TRACE LITHIUM IN SOME REFRACTORY OXIDES BY A HOLLOW-CATHODE DISCHARGE TUBE. Matic, J. S.; Pesic, D. S. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). Appl. Spectrosc., 22: 63-5(Jan.-Feb. 1968).

A spectrographic method is described for the determination of low concentration lithium in U_3O_8, ZrO_2, ThO_2, and Al_2O_3 using a hollow-cathode discharge tube. The results showed that the method provides greater sensitivity as compared to the carrier-distillation method by a factor of about 10. The precision is satisfactory at a greater concentration of Li. From the preliminary data, it is also believed that the method can be extended to the determination of other alkalies in the same oxides. (P.C.H.)

12246 EXTRACTION-RADIOMETRIC DETERMINATION OF TETRAPHENYLBORATE ANIONS BY THE METHOD OF CONCENTRATION-DEPENDENT SEPARATION USING ^{137}Cs. Kyrs, Miroslav; Pivonkova, Marie (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Chem. Listy, 61: 1502-5(Nov. 1967). (In Czech).

The extraction–radiometric determination of tetraphenylborate anions was accomplished by extraction of sodium tetraphenylborate using nitrobenzene at pH of 10 and using microquantities of ^{137}Cs and measuring the activity in both phases. The method can be used to determine reagent concentration of 3×10^{-5} to 10^{-2} molar with an accuracy of ±7.6%. (tr-auth)

12247 METHODS OF MEASURING THE CONCENTRATION OF IRON IN QUARTZ BY MEANS OF GAMMA- AND X-RAYS. Dziunikowski, B. (Inst. of Nuclear Techniques, Krakow). Trans. Inst. Mining Met., Trans./Sect. B, 76: 202-?(Nov. 1967).

Methods of determining the concentration of iron in iron-bearing sands based on the use of radioisotope sources and measuring the scatter and transmission of the x and γ rays and the emission of characteristic x rays are described. Factors that influence sensitivity and accuracy are discussed and it was concluded that methods involving scatter and transmission are the more useful in determining concentrations up to 45% Fe. (auth) (UK)

12248 SEQUENTIAL SCHEME FOR THE DETERMINATION OF SEVERAL FALL-OUT NUCLIDES IN WATER. Bathie, F. M.; Burden, B. A. (Lab. of the Government Chemist, London). Analyst, 93: 1-12(Jan. 1968).

A method is described for the sequential separation and measurement of fallout nuclides of Ru, Mo, Te, Sb, and Sn in water. The nuclides, together with added carriers, were separated from 10 litres of sample by precipitation and solvent extraction methods, and counted on a low background anti-coincidence β-counter. Chemical recoveries of added carriers ranged from 46% for Sb to 66% for Mo. The limits of detection range from 0.02 to 0.08 picocuries per litre. (auth) (UK)

12249 DETERMINATION OF ZINC CONTENT IN UPPER-SILESIAN LEAD–ZINC ORES BY MEANS OF PHOTON ACTIVATION ANALYSIS. Niewodniczanski, Jerzy (Inst. of Nuclear Techniques, Krakow); Sulin, Veniamin V.; Vitozhenc, Ghenryk Ch. Nukleonika, 12: 1153-9(1967).

The feasibility of zinc determination by means of photon activation analysis was studied on samples of lead–zinc ores from Bytom Basin. Ore samples containing considerable admixtures of lead (up to 35%) and iron (up to 23%), and weighing 180 to 350 g were irradiated by photons with maximum energy of 13.6 MeV, the dose amounting to about 100 R. The mean relative standard deviation of the measurement obtained from repeated measurements of one sample with average composition is 2.5%. Some attempts of lead and iron determination in these ores were also made. (auth)

12250 HIGH-RESOLUTION AUTORADIOGRAPHY OF TRACE BORON IN METALS AND SOLIDS. Hughes, J. D. H.; Rogers, G. T. (United Kingdom Atomic Energy Authority, Wantage, Eng.). J. Inst. Metals, 95: 299-302(Oct. 1967).

An autoradiographic method of determining the spatial distribution of boron in solids with a resolution of 2 μm was demonstrated over a boron concentration range of 20% to 1 ppM. The products from the $^{10}B(n,\alpha)^7Li$ reaction produce tracks in a cellulose acetobutyrate replica exposed to a thermal–neutron flux while in contact with the specimen. The tracks are revealed by etching in aqueous KOH at 50°C. Track density is proportional to boron content at a given irradiation down to <10 ppM. Some latent-image fading was observed with irradiations of >100 h. (auth) (UK)

12251 DETERMINATION OF BORON IN GLASS BY THERMAL NEUTRON CAPTURE GAMMA-RAY ANALYSIS. Garbrah, B. W.; Whitley, J. E. (Scottish Research Reactor Centre, Glasgow). Glass Technol., 8: 154-6(Dec. 1967).

The application of a nuclear method to the determination of boron in glass was investigated. Samples of glasses with boron concentrations ranging from 1 to 7% were analysed and an accuracy of 1% demonstrated. The method employed a neutron beam from a reactor and a multichannel analyser, the application to on-line analysis with simpler equipment is discussed. (auth) (UK)

12252 USE OF SHORT-LIVED RADIONUCLIDES IN ACTIVATION ANALYSIS. Lukac, Peter; Tolgyessy, Juraj (Chemico-Technological Inst., Bratislava). Chem. Listy, 61: 1177-97 (Sept. 1967). (In Czech).

The literature (98 references, largely U.S.A.) on the use of short-lived radionuclides in activation analysis is reviewed. The principles on which activation analysis is based are outlined, and a scheme is presented showing pre- and post-activation procedures for both destructive and nondestructive analysis. The advantages of using the short-lived isotopes are increased sensitivity and speed, with better resolution. Certain problems arise from the activation and detection conditions used, the speed required in the radiochemical separation, and the recording of the activities. Some apparatus and equipment are discussed, e.g., pneumatic sample-transport schemes, automatic counters, spectrometers, and analog computers. Details are given on specific elements. (TTT)

12253 NEUTRON ACTIVATION ANALYSIS OF MEDIEVAL CERAMICS. Aspinall, A.; Slater, D. N. (Univ. of Bradford, Eng.). Nature (London), 217: 388(Jan. 27, 1968).

Neutron activation analysis has been used with some success to distinguish between specimens of ancient pottery and glass, and differences in concentrations of trace elements in samples have been noted. A programme of work was initiated, using lithium-drifted germanium detectors, to examine the trace element constituents of pots from 80 British kiln sites, and some preliminary experiments are described. Irradiation was conducted in the BEPO reactor at Harwell. (UK)

12254 RAPID DETERMINATION OF ^{90}Sr IN URINE. Bogen, D. C. (Atomic Energy Commission, New York). Health Phys., 14: 131-3(Feb. 1968).

Reverse-phase partition chromatography was adapted for rapid determination of ^{90}Sr in large urine samples. A column is prepared containing the ligand di(2-ethylhexyl)ester of phosphoric acid, which is coated on to the inert support glass micro beads. The ^{90}Y daughter of ^{90}Sr is selectively absorbed by the column and subsequently eluted. The ^{90}Y is precipitated as the oxalate, beta counted, and the sample activity level obtained by computer data reduction. The chemical recoveries are better than 80%, precision of analysis is better than 5%, and no overall bias is observed. The procedure is rapid, large sample sizes can be

used for good sensitivity, and decontamination factors are satisfactory. (auth) (UK)

12255 FLAME-PHOTOMETRIC DETERMINATION OF SMALL AMOUNTS OF BARIUM AND STRONTIUM. Pungor, E.; Zapp, E. E.; Thege, I. Konkoly (Eotvos Univ., Budapest). Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Chim., 2: 463-72(1960). (In German).

The determination of strontium in the presence of calcium and barium in an oxyhydrogen flame is discussed. The relation between amounts of material sprayed and molecular band emission was investigated. A method for barium determination was also developed, which included reduction of the disturbance caused by aluminum and phosphates. (tr-auth)

12256 CHEMICAL ANALYSIS OF SOME TRACE IMPURITIES IN URANIUM DIOXIDE. Tada, Kakuzo; Masuda, Isoo (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rebyu, 22: 1339-44 (Nov. 1967). (In Japanese).

The determination of trace impurities, such as carbon, chlorine, fluorine, nitrogen, and silicon, in uranium dioxide for nuclear fuel is described. The methods of determining these impurities in uranium metal were so modified as to be applicable to the case of uranium dioxide. Different-size particles obtained by crushing pellets differed in carbon contents (higher in finer particles), and that the carbon contents are increased by further crushing of coarser particles. (auth) (NSA of Japan)

12257 ACTIVATION ANALYSIS OF SMOKY QUARTZ. Sasakura, Hiroshi; Kami, Hisao (Industrial Research Inst., Osaka Prefecture). Osaka Kogyo Gijutsu Shikensho Hokoku, No. 41, 73-6(Apr. 1967). (In Japanese).

Since the coloration of smoky quartz was believed to be due to aluminum atom in a silicon lattice site, activation analysis was carried out on irradiated smoky quartz that had both the colored part and a colorless part. The content of aluminum in the colored part was in good agreement with that in the colorless part in the range of experimental error. This result suggests that the ions accompanying aluminum (for example, H^+, Li^+, or Na^+ etc.) play an essential role in the coloration of smoky quartz. (auth) (NSA of Japan)

12258 ON METAL IONS IN THE WATER COOLANT OF WWR-S REACTOR. Schneer-Erdey, A.; Szabo, E.; Csada, G. I. (Hungarian Academy of Sciences, Budapest). Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Chim., 8: 27-41(1966).

The water used as coolant, moderator, and reflector in the WWR-S reactor and activated beyond the extent attributable to radiolysis, was analyzed with particular regard to the short- and long-lived metal ions originating from the fast and slow neutron activation of contaminants partly inevitable during operation, partly due to corrosion. The short-lived isotopes were collected and measured. The long-lived active metal ions were separated by precipitation with carrier and by paper chromatography, and the activities and energy distribution of the metals were measured. In addition to gamma peaks and Rf values whenever possible also the half-life was measured in order to identify the individual elements. In the water the short-lived isotopes ^{24}Na, ^{56}Mn, ^{64}Cu can be conveniently detected. Gamma spectrometry is used also for the identification of the long-lived isotopes ^{51}Cr, ^{60}Co, ^{65}Zn, ^{113}Sn, and ^{124}Sb. After paper chromatographic separation, chemical methods permit the identification of the ions Al^{3+} and Cu^{2+}, which cannot be detected by activity measurement. (auth)

12259 (n,γ) ANALYSIS OF HUMAN BLOOD. Asai, Takuo; Meren, Eiichiro; Okumoto, Masaaki; Sato, Yuji; Azuma, Toshio. Annu. Rep. Radiat. Center Osaka Prefect., 7: 99-103(1966).

Elements in the blood of healthy adults and cancer and diabetic patients were measured by (n,γ) activation. The samples were irradiated for 10 hr or 1 hr in a neutron flux of 2×10^{13} or 4×10^{12} n/cm²/sec at the Kyoto University Reactor, Kumatori, Osaka. The gamma spectra from these activated samples were measured. The elements Na, Ga, Mn, Cl, Ni, Zn(Fe), Rb, Br, Au, Cu, Sr, K, Cr, and Hg were assumed to exist. Their statistical distribution was not determined for the few samples observed. (auth)

12260 (γ,n) ACTIVATION ANALYSIS OF Zn, Ni, AND Cu METALS CONTAINED IN RUBBER VULCANIZATES. Azuma, Toshio; Sato, Yuji; Tsurugi, Jituso; Imamura, Kunio. Annu. Rep. Radiat. Center Osaka Prefect., 7: 21-6(1966).

The sensitivity curves for (γ,n) activation analysis were measured for Zn, Ni, and Cu in rubber vulcanizates. Natural rubber (RSS # 1), stearic acid, sulfur, and accelerator (DM) were mixed and cured. The mixture was divided into several parts, and mixed with known amounts of Zn, Ni, and Cu metals. The samples were irradiated for 60 min by bremsstrahlung from the electron linac of the Radiation Center of Osaka Prefecture. The sensitivity curves were obtained from the gamma peaks measured by a $3 \times 3''$ NaI counter, where 1 to 10, 0.1 to 1, and 0.1 to 1×10^{-3}% are assumed for Zn, Ni, and Cu metals, respectively. (auth)

12261 DETERMINATION OF MOLYBDENUM IN THE GASEOUS PHASE IN UF_6 BY ATOMIC ABSORPTION SPECTROSCOPY. Sassoulas, R.; Serpinet, J. (Societe Ugine Kuhlmann, Lyon). Spectrochim. Acta, Part B, 23: 227-34(Feb. 1968). (In French).

A procedure for the determination of molybdenum hexafluoride in uranium hexafluoride by atomic absorption spectrometry, without any hydrolysis, is described. Gaseous uranium hexafluoride is introduced into a premix burner and molybdenum determined from a calibration curve obtained with synthetic mixtures of uranium hexafluoride and molybdenum hexafluoride. The optimum working range is between 10 and 50 ppM of molybdenum in uranium. The detection limit obtained is 2 ppM. (auth) (UK)

12262 NEUTRON-CAPTURE GAMMA-RAY ACTIVATION ANALYSIS. DESIGN OF APPARATUS FOR TRACE ANALYSIS. Lombard, S. M.; Isenhour, T. L.; Heintz, P. H.; Woodruff, G. L.; Wilson, W. E. (Univ. of Washington, Seattle). Int. J. Appl. Radiat. Isotop., 19: 15-22(Jan. 1968).

An apparatus designed for elemental trace analysis using neutron-capture γ radiation is described. An optimized collimator and filter system yields a high thermal-neutron flux while maintaining low fast-neutron and γ levels at the sample. The shield for the NaI(Tl) scintillation detector is designed to give maximum counting geometry commensurate with adequate background attenuation. Interfering radiation from the sample is subtracted from the capture γ spectra during irradiation by modulating the neutron beam with a high resolution chopper and gating the logic unit of the multichannel analyzer in phase with the neutron bursts. The method is applied to the determination of boron and cadmium. (auth) (UK)

12263 RADIOMETRIC TITRATION OF TRACE AMOUNTS OF ZINC. Landgrebe, A. R. (National Bureau of Standards, Washington, D. C.); McSharry, W. O.; Cefola, M. Int. J. Appl. Radiat. Isotop., 19: 23-6(Jan. 1968).

A method of radiometric titration for the determination of trace amounts of metals was developed. The EDTA complex of the metal to be determined is formed, and the excess uncomplexed metal ions are removed by means of a cationic exchanger. A titration curve is then constructed by plotting the activity of the liquid phase vs the amount of EDTA added. Both the batch and column method were tried and the batch method is easier from a manipulative point of view. A new method of determining the end point was developed. If both the resin and solution are counted, this is a simple way of determining the half equivalent point. Methods are underway to maximize the sensitivity for zinc by chelating radiometric titration, using ^{65}Zn tracer. (auth) (UK)

12264 ANALYTICAL APPLICATIONS OF GAS CHROMATOGRAPHY IN THE NEUTRON ACTIVATION ANALYSIS OF SHORT-LIVED ISOTOPES. Cram, Stuart Proud. Urbana, Ill., Univ. of Illinois, 1967. 189p.
Thesis.

The coupling of gas chromatography and neutron activation analysis is shown to be analytically significant for trace analysis, and short-lived isotopic determinations. The inherent sensitivity of the activation method was enhanced by post-irradiation chromatographic separations, and conversely, chromatographic determinations and separations are enhanced by using radioisotope systems. Rapid and remote sample handling facilities were developed for automated operation during the analyses. A pulsing system was triggered at critical times during the experiment to measure the irradiation and decay times to tenths of seconds, initiate the sampling and injection system, and activate the detector-readout systems. The decay time after leaving the reactor until sample injection onto the chromatographic column was nominally less than two seconds. A multiple detector system of thermal conductivity (TC), scintillation spectrometry, and hydrogen flame ionization (HFI) followed the separation stage (<30 sec after injection) to provide a versatile and sensitive detector system capable of simultaneous qualitative and quantitative analyses of radio isotopic and nonactivated effluents. The TC and HFI detectors were oscilloscopically recorded with either a linear or logarithmic display. The scintillation data were analyzed with a 400 channel analyzer in either a multichannel pulse-height analysis mode, or a multichannel scaling mode. Lower trace level determinations were demonstrated for ^{19}F than previously reported by (n,γ) activation using direct counting procedures and instrumental data reduction. This implies that the analysis of the halogens is not limited by their short half-lives or matrix interferences, but

by their activation cross sections and the available reactor flux. The chromatographic removal of matrix activities, radio-nuclides with overlapping photopeaks, and masking activities was shown to be complete and efficient, and thereby served to "clean-up" multichannel pulse-height spectra. The recoil effects in organic halides during reactor irradiations were shown to be effective as a means of characteristically "fingerprinting" series of related compounds by their "chromatographic spectra." These "spectra" were obtained by separating the radiolysis degradation products, and recording the sensitive and characteristic response of the multiple detector system so that samples may be cataloged for identification. The qualitative determination of radioisotopes in the effluent of the gas chromatograph, or from the radiolysis reaction fragments, was accomplished by sequential pulse-height analysis. These simple spectra greatly reduce the data interpretation required, and were used to identify the isotopic constituents of an effluent peak (and thereby determine its purity and specific activity), and peaks of interest in activated sample mixtures. (Disser. Abstr.)

12265 SAMPLE PREPARATION FOR LIQUID SCINTILLATION COUNTING. Turner, J. C. R.C.C. Review No. 6. Amersham, Eng., United Kingdom Atomic Energy Authority, Radiochemical Centre, 1967. 32p.

The subject is surveyed under the following headings: selective literature review; liquid scintillation solvents and solutes; counting in solution (water and aqueous solutions, inorganic salts; biological materials–solubilization methods, combustion and oxidation procedures, $^{14}CO_2$ and $^{35}SO_2$, decolorization for counting in solution–solution counting with toluene/Triton X-100 liquid scintillant); counting suspensions; counting paper and thin-layer chromatograms and samples dried on to paper or glass fibre; counting emulsions; counting gases and vapors; counting flowing aqueous solutions; theoretical aspects of liquid scintillation counting; determination of counting efficiency; and counting in solution–some sources of error. (103 references.) (UK)

12266 ISOTOPES IN CHEMISTRY. Duncan, J. F.; Cook, G. B. Oxford, Clarendon Press, 1968. 273p. 55s.

Information is given on: principles of isotope chemistry; radioactivity; detection of isotopes; tracer chemistry; zero concentration gradients; exchange reactions; isotope effects; isotopic studies of reaction mechanisms; chemistry of nuclear processes; isotopic methods of analysis; and chemistry of the radioactive elements. (UK)

12267 SCHIMBUL IONIC. TEORIA SI APLICATIILE SALE IN CHIMIA ANALITICA. (Ion Exchange. Theory and Applications in Analytical Chemistry). Sabau, Carmen. Bucharest, Editura Academiei Republicii Socialiste Romania, 1967. 305p.

A brief review is given on the definition of chromatographic processes and separation methods. Physical chemistry of ion exchange, analytical application of ion exchangers, ion exchange of high-molecular-weight compounds, chromatographic and radiochemical methods for determining microelements, and methods for determining metals are discussed as well as ion exchange in mixed and nonaqueous media and chemical effects of nuclear transformations. (858 references) (R.V.J.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 12266, 12360, 12402, 12963, 12980, 13002, 13003, and 13048.

12268 (AWRE-O-45/65) URANIUM COMPATABILITY STUDIES. PART 6. THE PRODUCTS AND MECHANISM OF THE URANIUM–WATER AND URANIUM HYDRIDE–WATER REACTIONS. Baker, M. McD.; Less, L. N.; Orman, S. (Atomic Weapons Research Establishment, Aldermaston (England)). July 1965. 29p. Dep. CFSTI. UK.

Uranium and water react to form hydrogen and a solid product containing nonstoichiometric uranium dioxide, $UO_{2.06\pm0.02}$, and 2 to 9% UH_3. The relative amounts of the products vary with the pressure of water vapor and to a smaller extent with the temperature and batch of uranium, but are independent of hydrogen pressure and reaction time. The UH_3-H_2O reaction is similar in many respects to the $U-H_2O$ reaction. A mechanism is suggested for the $U-H_2O$ reaction involving UH_3 as an intermediate product. (auth)

12269 (AWRE-R-6/58) PHYSICO-CHEMICAL STUDIES OF FUSED SALT SYSTEMS. PART 1. DENSITY OF THE FUSED EUTECTIC MIXTURE OF SODIUM FLUORIDE AND URANIUM TETRAFLUORIDE. Hutchinson, S. K.; Baker, M. McD.; Jones, P. M. S.; Bleloch, J. W. (Atomic Weapons Research Establishment, Aldermaston (England)). 1959. 24p. Dep. CFSTI. UK.

The density of the fused eutectic $NaF-UF_4$ (74 mole % NaF and 26 mole % UF_4) was determined over the temperature range 610 to 900°C by three methods: pycnometry, buoyancy of a platinum bob, and shape measurements on a sessile drop. Measurements made by the three methods agreed to within the experimental errors involved, pycnometry giving the most accurate results. The density ρ_t (in g/ml) at t°C is given by: $\rho_t = 4.307 - 0.00192\,(t-600) + 1.5\times10^{-6}\,(t-600)^2$. (auth) (UK)

12270 (COO-1383-1) INTERACTIONS ON METALLIC SURFACES. Progress Report, February 1, 1967–February 1, 1968. Gomer, Robert (Chicago Univ., Ill.). Contract AT(11-1)-1383. 4p. Dep. CFSTI.

Developments are reported for studies on: adsorption of CO on single crystal planes of W field emitters; adsorption of CO on Pt; adsorption of O on Pt; mass spectrometric measurements on desorption. (P.C.H.)

12271 (COO-1707-1) THERMODYNAMIC INVESTIGATION OF ALKALI METAL MIXTURES. Technical Progress Report, May 1, 1967–February 1, 1968. Ott, J. Bevan; Goates, J. Rex (Brigham Young Univ., Provo, Utah). Jan. 15, 1968. Contract AT(11-1)-1707. 6p. Dep. CFSTI.

The design, construction, and testing of experimental apparatus and the acquisition of commercial equipment and supplies for studies on the thermodynamics of alkali metal mixtures are discussed. Preliminary measurements on the Na–K system are described. (P.C.H.)

12272 (DP-MS-67-82) ISOMER SHIFTS IN NEPTUNIUM COMPOUNDS. Stone, J. A.; Pillinger, W. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sept. 1967. Contract AT(07-2)-1. 17p. (CONF-671201-1). Dep. CFSTI.

From Conference on The Mossbauer Effect, Faraday Society, London, England.

Characteristic isomer shift ranges were measured for several valence states of neptunium, using the Mössbauer resonance of the 59.54-keV gamma ray of ^{237}Np. Isomer shifts were observed for various neptunium compounds as absorbers, with an ^{241}Am–Th alloy as a single-line source, and for the charge states produced by alpha decay of various ^{241}Am compounds as sources, with a single-line NpO_2 absorber. Approximate shifts for the 0, 3+, 4+, 5+, and 6+ valences of neptunium are, respectively 0.0, +4.1, +0.2, −1.5, and −3.5 cm/sec, with respect to NpO_2. These data show that the fractional change in nuclear deformation is negative and that the excited- and ground-state quadrupole moments are equal to within 1%. The unusually large isomer shifts observed, spanning more than 2000 natural line-widths, offer an extremely sensitive method for investigating chemical bonding in neptunium-containing systems. (auth)

12273 (K-1720) PURIFICATION AND PELLETIZATION OF SULFUR FOR NEUTRON DOSIMETRY. Rivers, R. D.; Kienberger, C. A. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Feb. 1, 1968. Contract W-7405-eng-26. 25p. Dep. CFSTI.

Techniques were developed for purifying and pelletizing elemental sulfur, for application in neutron detectors for area dosimetry. Purification involves the destruction of organic materials by boiling the sulfur with a small amount of magnesium oxide, and distillation of the sulfur to separate it from carbonaceous matter and inorganic impurities. The product contains less than 1 ppM of the common metallic impurities and no detectable (<1 ppM) carbonaceous matter. A unique hot dispensing system was devised for precise delivery of liquid sulfur for casting of 22-gram pellets. An automatic syringe system withdraws the molten sulfur from a reservoir and delivers it to Pyrex casting rings positioned on a rotating Teflon cold plate. A hot inert gas, directed over the top surface of the pellets, melts a thin layer of sulfur, forming a smooth uniform surface. The average weight of 20 pellets, selected at random, was 22.000 g with a standard deviation of ±0.009 g per pellet. (auth)

12274 (NP-17197) STUDY OF URANIUM(IV) NITRATE AS REDUCTANT FOR PLUTONIUM. I. THE PREPARATION OF URANIUM(IV) NITRATE SOLUTIONS. Technical Report No. 118. Lopez-Menchero, E.; Gehem, L.; Eschrich, H.; Hansen, P.; Centeno, J.; Aerts, R. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Nov. 1966. 63p. (ETR-180). Dep.

Electrolytic reduction of uranyl nitrate solutions has been successfully used to prepare pure aqueous and organic uranium(IV)

nitrate solutions for analytical purposes. It was also used to produce hydrazine–nitrate-stabilized aqueous uranium(IV) nitrate solutions for use as plutonium reductant in a "Purex" type aqueous reprocessing plant. Unstabilized solutions containing more than 99.9% uranium(IV) were prepared by using an electrolytic cell with platinum electrodes. For plant use, two types of cell were developed. Both have a platinum anode, but differ in using mercury or platinum as cathode material. Overall and differential current efficiencies of 100% were obtained at current densities of 250 mA/cm^2 for up to 50% uranium(VI) conversion; for 85% conversion the overall and differential current efficiencies are 90% and 65%, respectively. (auth)

12275 (ORNL–4094, pp 28-39) SOL-GEL PROCESS DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

The continuous-reduction reactor system, which operates at 300 psig, with uranyl nitrate being fed by a diaphragm pump, was modified by replacing the existing (1.5 in. dia) reactor with a larger one (2 in. dia), and by metering the inlet hydrogen to maintain consistent agitation within the reactor. Ten 1-kg batches of urania sol were prepared in a batch precipitation-filtration-peptization vessel, using the process requiring precipitation to a pH of 9. These sols generally had a low U(IV)/U(total) atom ratio, slightly more than 0.80, but were suitable for forming microspheres. A large-scale criticality-safe sol-making facility, called the P^{2}C^{2}D (Precipitation-Peptization-Countercurrent Decantation) system was tested in two 70-hr runs. Numerous operating difficulties were resolved by modification of equipment, but some problems are still encountered in transferring the slurry between the stages of the countercurrent decanters. An acceptable pump was not found for transferring the settled, washed precipitate from the final washer to the continuous peptizers. The uranium concentration in the sol is much lower than desired. A countercurrent wash column was tested and found to operate satisfactorily. Ten kilograms of urania microspheres was prepared. Clustering or distortion of microspheres was frequently observed when Ethomeen S/15 was used as the surfactant in the 2-ethylhexanol; this was greatly reduced by using equal concentrations of Ethomeen S/15 and Span 80. (auth)

12276 (ORNL–4094, pp 40-9) THORIUM FUEL-CYCLE STUDIES. (Oak Ridge National Lab., Tenn.).

Sol-gel thoria microspheres of relatively nonuniform diameter (and less than 80 μ in mean diameter) can be easily and efficiently prepared by using mechanical agitation to disperse and suspend droplets of sol in 2-ethyl-1-hexanol. An investigation was started to determine the gelation times of droplets of thoria sol, suspended in flowing 2-ethylhexanol, by measuring the droplet diameter until shrinkage no longer occurs. (auth)

12277 INFRARED ABSORPTION OF HDO IN WATER AT HIGH PRESSURES AND TEMPERATURES. **Franck, E. U.; Roth, K. (Technische Hochschule, Karlsruhe, Ger.). Discuss. Faraday Soc., No. 43, 108-14(1967).**

By use of a specially designed cell with a sapphire window the absorption of the OD-stretching vibration of HDO in H_2O was measured at frequencies from 2200 to 2900 cm^{-1} and at temperatures and pressures from 30 to 400°C and from 50 to 4000 bars. At the supercritical temperature of 400°C and pressures below 200 bars (corresponding to a water density of 0.1 g/cm^3) the rotational structure of the vibration band of free water molecules was observed. At higher density only one intensive absorption maximum with simple shape was observed at all temperatures. This is considered as support for the continuum model for water in the liquid and in the dense supercritical state. (auth)(UK)

12278 A NEUTRON-DIFFRACTION STUDY OF THE PHASE IN THE PALLADIUM-GOLD-HYDROGEN AND PALLADIUM-GOLD-DEUTERIUM SYSTEMS. **Maeland, A. J. (Explosives Lab., Picatinny Arsenal, Dover, N. J.). Can. J. Phys., 46: 121-4(Jan. 15, 1968).**

It was shown previously that both hydrogen and deuterium in β phase Pd–H and Pd–D are situated in the octahedral interstices of the fcc palladium lattice, but attempts to determine the atomic positions in the α phase proved inconclusive, since only small amounts of gas are contained in this phase at room temperature. In order to locate the hydrogen atoms in the α phase by neutron diffraction the concentration must be increased. This can be accomplished by increasing the temperature and gas pressure. However, another method that avoids the use of high temperature and pressure was used. The method is based on the observation that the addition of gold or silver to palladium results in increased hydrogen solubility in the α phase. Neutron diffraction results on powdered α phase gold–palladium–hydrogen and gold–palladium–deuterium samples showed that both hydrogen and deuterium are located in the octahedral positions of the fcc metal lattice. It seems reasonable to assume that the same positions are occupied in the α phase of Pd–H. (auth)(Canada)

12279 ELECTRIC FIELD GRADIENT CALCULATIONS WITH ONE-CENTRE EXPANSION WAVE FUNCTIONS. **Pyykko, P. (Univ. of Turku, Finland). Proc. Phys. Soc. (London), 92: 841-2 (Nov. 1967).**

Values of the electric field gradient were calculated for the deuteron sites of the molecular systems BD_4^-, CD_4, ND_4^+, AlD_4^-, SiD_4, PD_4^+, DF, DCl, D_2O, D_2S, ND_3 and PD_3, using the one-center expansion wave functions of Albasiny and Cooper (Proc. Phys. Soc. Vol. 88. pp. 315-23, 1966) and of Moccia. Reasonably good agreement with experiment was obtained. (auth)(UK)

12280 STABILITY OF HYDROSOL OF ARSENIC TRISULPHIDE IN THE LIGHT OF D.L.V.O. THEORY. **Daluja, K. L.; Srivastava, S. N. (Agra Coll., India). Bull. Chem. Soc. Jap., 41: 17-25(Jan. 1968).**

The stability of the negative As_2S_3 sol of mean particle diameter 90 Å was studied in the presence of cations of different valence viz. Na^+, Ba^{2+}, UO_2^{2+}, Al^{3+} and Th^{4+} using the Derjaguin, Landau, Verwey, and Overbeek (D.L.V.O.) theory. The zeta potential (assumed to be equal to the surface potential) of the sol particles was calculated from electrophoretic measurements as a function of ionic strength. Knowledge of zeta potential permitted the calculation of repulsive energy V_R, and the energy of attraction V_A was estimated from physicochemical data. The stability ratio, W, was calculated from interaction profiles made from combination of the two energies. The stability factor, F, was also estimated from the Derjaguin equation, but it was not satisfactory presumably owing to the exclusion of V_A. In general, the interaction between As_2S_3 particles could be interpreted in the light of D.L.V.O. theory. The flocculation powers of cations were in the order of $Al^{3+} > Th^{4+} > UO^{2+} > Ba^{2+} > Na^+$. The anomalous behavior of thorium is perhaps due to its hydrolysis. (auth)

12281 INFRARED SPECTRUM OF CrH and CrD. **O'Connor, S. (Univ. Coll., Dublin). Proc. Roy. Irish Acad., Sect. A, 65: 95-111(June 1967).**

The $^6\Sigma^+ - {}^6\Sigma^+$ infrared systems of CrH and CrD have been photographed in the second order of a 21′ concave grating, using a heavy current discharge tube. The rotational analysis of the (0,0) band of CrD, together with partial analysis of the (1,0) and (1,1) bands of CrH are presented. The rotational structure of the v = 0 level of both the upper and lower electronic states of the two molecules was examined in as much detail as possible in the absence of satellite branches. Some deviation from the normally expected structure is indicated. (auth)

12282 X RAY STUDIES OF THE AB_2O_8 COMPOUNDS. **Trunov, V. K.; Kovba, L. M. (Moscow State Univ.). Zh. Neorg. Khim., 12: 3218-20(Nov. 1967). (In Russian).**

Following an earlier study of the compound ZrW_2O_8, which possesses a cubic structure with a = 9.158 Å, the compounds HfW_2O_8, ZrW_2O_8, $ZrMo_2O_8$, and $HfMo_2O_8$ were subjected to an x-ray diffraction study. The specimens were prepared by calcining the stoichiometric mixtures of the oxides in air in quartz ampoules. The compounds HfW_2O_8 and ZrW_2O_8 were found to possess identical structures; the cubic cell parameter was a = 9.13 Å, with a probable spatial configuration of $P4_23$. Single crystals of $ZrMo_2O_8$ and $HfMo_2O_8$ were prepared by removing excess MoO_3 from the molten mixture of $MeMo_2O_8 + MoO_3$ at 900°C. These compounds crystallized in the hexagonal system, with lattice parameters of a = 10.06 and c = 11.72 Å and a = 10.11 and c = 11.73 Å for the zirconium and hafnium compound, respectively. The interlayer distances were also determined and presented in a tabular form. (TTT)

12283 COMPLEX FORMATION OF TETRAVALENT THORIUM AND URANIUM IN PHOSPHATE SOLUTIONS. **Moskvin, A. I.; Essen, L. N.; Bukhtiyarova, T. N. Zh. Neorg. Khim., 12: 3390-2(Dec. 1967). (In Russian).**

The formation of complexes of tetravalent uranium and thorium with the HPO_4^{2-} molecule was investigated, in order to establish whether there is a similarity with the complexes formed by Pu^{4+}. Experimental work involved determination of the solubility of $Th(HPO_4)_2 \cdot 4H_2O$ in phosphoric acid solutions at various concentrations, keeping the H ion concentration at 0.35 mole/liter; for the corresponding study of the U(IV) compounds, earlier literature data on the solubility of $U(HPO_4)_2 \cdot 4H_2O$ in phosphate solutions were used. The numerical values of the calculated constants of stability of Th^{4+}, U^{4+}, and Pu^{4+} were very similar; this is due to the closeness of the ionic radii of the actinide elements in their tetravalent state. The graphically determined solubility product, 1.3×10^{-27}, derived from experimental data, differed strongly from the value of 9.0×10^{-21}, reported in 1956 and calculated without having taken the effect of the complex formation into

account. The graphically determined value of the corresponding uranium compound was 1.4×10^{-27}; the theoretical value was very close. The similarity of the solubility products is due to the closeness of the ionic radii of thorium and uranium. (TTT)

12284 THE CHEMICAL STATES OF FISSION-PRODUCT IODINE EMANATING INTO A HIGH TEMPERATURE AQUEOUS ENVIRONMENT. Castleman, A. W. Jr.; Tang, I. N.; Munkelwitz, H. R. (Brookhaven National Lab., Upton, N. Y.). J. Inorg. Nucl. Chem., 30: 5-13(Jan. 1968).

The chemical states of iodine in an aqueous environment, at very low concentrations and at temperatures of 1000 to 1300°C, were investigated using iodine produced by neutron fission of U, UO_2, and U_3O_8. The results showed that the final forms of iodine depend on the chemical nature of the environment, being largely elemental (I^0) in a neutral or oxidizing atmosphere and largely I^- in a reducing atmosphere. Only the reaction $I + H_2 = HI + H$ can account for the extent and rate of formation of HI observed when tracer-level iodine is released into steam containing hydrogen. Methyl iodide is produced by reactions between atomic iodine and impurities in the system. All experimental results can be explained on the basis of known iodine states. (auth) (UK)

12285 STUDIES ON TTA COMPLEXES WITH METAL IONS. IV. INVESTIGATIONS OF SOME CRYSTALLINE FORMS OF URANYL-TTA COMPLEX. Baskin, Y.; Ferraro, J. R. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 30: 241-51 (Jan. 1968).

Crystals of uranyl-TTA complex (UO_2T_2) were prepared from various solvents. Two different monoclinic forms crystallize from ethanol and methanol, while one basic orthorhombic form crystallizes from benzene or carbon tetrachloride. Single-crystal, powder diffraction, chemical, optical, spectroscopic, and melting point data are presented for the different forms. Monoclinic crystals obtained from ethanol and methanol transform to the orthorhombic form on exposure to air. Data are presented on the transformation, which involves an exchange between solvated alcohol and water hydration. The effects of solvated alcohol on the ir spectrum are discussed. (auth) (UK)

12286 THE CHEMISTRY OF URANIUM(IV). IV. TEN-COORDINATE U(IV) AND Th(IV) COMPLEXES OF TROPOLONE. Selbin, J.; Ortego, J. D. (Louisiana State Univ., Baton Rouge). J. Inorg. Nucl. Chem., 30: 313-17(Jan. 1968).

Five compounds, LiT, ThT_4, $LiThT_5$, UT_4, and $LiUT_5$, (T = tropolone) were prepared and their vibrational and electronic spectra were examined in a comparative and critical manner in order to shed more light on the possible ten-coordinate nature of these complexes. The spectral studies included Nujol mull ir spectra in the 4000 to 650 cm^{-1} range, dimethylsulfoxide (DMSO), and dimethylformamide (DMF) solution spectra as well as Nujol mull 300 and 77°K spectra in the 6600 to 20,000 cm^{-1} (15,000 to 5000 A) region and 95% ethanol solution uv spectra in the 4500 to 2200 A range. (P.C.H.)

12287 INTERACTION BETWEEN LIQUID PLATINUM AND SOME TRANSITION METAL CARBIDES. Warren, R. (Stora Kopparbergs Bergslags AB, Soderfors, Sweden). J. Nucl. Mater., 25: 125-7(1968).

A study was made to determine whether liquid platinum decomposes transition metal carbides. In all systems there was a considerable reaction between the carbide and platinum to form graphite. (M.C.G.)

12288 THE REACTION OF GASEOUS BROMINE PENTAFLUORIDE WITH URANIUM COMPOUNDS. II. THE KINETICS OF THE REACTION WITH U_3O_8, UO_2 AND UO_3. Jarry, Roger L.; Steindler, Martin J. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 30: 127-32(Jan. 1968).

The following equations represent the combined temperature and pressure dependence of the reactions with BrF_5: U_3O_8, $\log k' = 0.90 \log P - 2000/T - 0.220$; UO_2, $\log k' = 0.84 \log P - 1630/T - 0.270$; and UO_3, $\log k' = 1.05 \log P - 1680/T - 0.767$. Activation energies of 9.2, 7.5, and 7.7 kcal/mole were calculated for the reactions of U_3O_8, UO_2, and UO_3, respectively. Bromine was the other volatile product of the reaction, along with UF_6 and oxygen. These reactions proceed through the formation of UO_2F_2 as an intermediate. The presence of UF_4 in the reaction of U_3O_8 with BrF_5 was probably due to the interaction of the product UF_6 with U_3O_8. (auth) (UK)

12289 THE FORMATION OF COMPOUNDS IN THE UO_3–ThO_2 SYSTEM. Boekschoten, H. J. C.; Kema, N. V. J. Inorg. Nucl. Chem., 30: 119-26(Jan. 1968).

An investigation is reported on the chemistry of mixtures of UO_3 and ThO_2 suspended in water at temperatures up to 250°C. The suspensions were prepared by mixing washed thorium hydroxide precipitates and UO_3 powder, and also by co-precipitation of mixtures of solutions of $Th(NO_3)_4$ and $UO_2(NO_3)_2$ with NaOH. It appeared that above ±210°C a compound with the formula $UThO_5$ could be formed. Data on the x-ray diffraction pattern and the thermal stability of this compound are given. The fcc lattice of ThO_2 can take up about 25 mole percent UO_3 maximal at 250°C. Below 210°C another UO_3–ThO_2 compound was observed. (auth) (UK)

12290 DISTRIBUTION OF AMERICIUM BETWEEN LIQUID PLUTONIUM AND A FUSED SALT. EVIDENCE FOR DIVALENT AMERICIUM. Mullins, L. J.; Beaumont, A. J.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). J. Inorg. Nucl. Chem., 30: 147-56(Jan. 1968).

The distribution of Am between liquid Pu metal and a fused salt conprising NaCl–KCl containing $PuCl_3$ was studied at 698, 730, and 775°C over a $PuCl_3$ mole fraction range of 6×10^{-3} to 2×10^{-2}. The distribution data are consistent with the following equation: $Am(l) + \frac{2}{3}PuCl_3(l) + \frac{2}{3}Pu(l) + AmCl_2(l)$. From the temperature dependence of the equilibrium constant a value of −3.5 kcal was estimated for ΔH^0 for the above reaction. (auth) (UK)

12291 INVESTIGATION OF SYNTHETIC INORGANIC ION EXCHANGERS. Szirtes, L.; Zsinka, L.; Zaborenko, K. B.; Iofa, B. Z. (Inst. of Isotopes, Budapest. Moscow State Univ.). Acta Chim. Acad. Sci. Hung., 54: 215-29(1967).

As a novel member of groups of synthetic inorganic ion exchangers, chromium phosphate has been prepared. At given ratios of PO_4/Cr, this compound can be best characterized by the formula $Cr_2O_3HPO_4$ and $Cr_2O(HPO_4)_2$, respectively. Some properties of this product were investigated and compared with those of zirconium phosphate and titanium phosphate. It was found that, though the radicals HPO_4^{2-} predominate in the prepared compounds, the presence of the radicals $H_2PO_4^-$ and PO_4^{3-} should also be taken into account. Further, as it follows from the close analogy between the curve of exchange capacity vs pH, and the dissociation curve of phosphoric acid, the formation of exchangeable H^+ ions may be attributed to the dissociation of the hydrogen phosphate groups present in the ion exchanger. Consequently, the mechanism of the ion exchange process is of a two-step nature (depending on the pH); the hydrogen ions formed in the process $H_2PO_4^- \rightarrow HPO_4^{2-}$ are exchanged in the first step, and those liberated by the dissociation $HPO_4^{2-} \rightarrow PO_4^{3-}$ in the second step. Further, it has been found that when low ratios of PO_4 metal are used i.e. when amorphous substances are formed, the adsorption properties are of importance. On the basis of the high degree of analogy observed, these conclusions may be extended to all three substances examined. The positive results concerning practical applicability justify the use of these ion exchangers in radiochemical practice, e.g., for the separation of ions formed with different activities in the case of simultaneous nuclear reactions, such as $^{59}Co(n,\gamma)^{60}Co$ and $^{59}Co(n,p)^{59}Fe$. (auth)

12292 STUDY, BY INFRARED SPECTROGRAPHY, OF THE HYDRATES OF URANYL NITRATE. Chottard, Genevieve; Fraissard, Jacques; Imelik, Boris (Faculte des Sciences, Paris. CEN, Saclay, France). Bull. Soc. Chim. Fr., No. 11, 4331-5(Nov. 1967). (In French).

Infrared absorption spectra of the hexa-, tri- and dihydrated uranyl nitrates were studied between 4,000 and 360 cm^{-1}, together with those of the corresponding deuteroxides. The absorption bands of the molecules of water were identified by means of isotopic exchange. The presence of fundamental bands due to the bidentate nitrate groups at a frequency higher than 1,600 cm^{-1} is excluded. For the hexa- and dihydrates it is possible to distinguish two types of water molecule: those that are coordinated to the uranium atom and those that are only bound by a hydrogen bond. The dihydrate presents water molecules only of the first type. (auth)

12293 ABSORPTION SPECTRA OF SbH AND SbD RADICALS. Bollmark, P.; Lindgren, B. (Univ. of Stockholm). Chem. Phys. Lett., 1: 480(Dec. 1967).

In absorption after flash photolysis of SbH_3 and SbD_3, spectra attributed to SbH and SbD radicals were observed. (auth)

12294 DIPOLE MOMENT AND POLARIZABILITY DIFFERENCES BETWEEN NH_3 AND ND_3. Halevi, E. A.; Haran, E. N.; Ravid, B. (Technion-Israel Inst. of Tech., Haifa). Chem. Phys. Lett., 1: 475-6(Dec. 1967).

Eight independent differential measurements were made of the dipole moment and polarizability of NH_3 and ND_3 at 40 to 205°C. (M.C.G.)

12295 NORMAL VIBRATIONS AND ASSIGNMENTS OF INFRARED SPECTRA OF PROPANE AND ITS DEUTERIUM

DERIVATIVES. Ogawa, Teiichiro; Hara, Jizaemon; Hirota, Kozo (Osaka Univ.). Nippon Kagaku Zasshi, 89: 19-22(Jan. 1968). (In Japanese).

Normal vibrations of propane and its nine deuterium derivatives were calculated by the GF matrix method. Modified Urey–Bradley potential field (F′ = 0, including a trans-interaction term) was assumed and nine force constants were determined by the least squares method so as to yield the best fit for the eighty-four observed frequencies of four derivatives of propane which were studied in detail. The standard errors of force constants were evaluated and the potential function seems reliable in order to assign the observed vibrational frequencies. Normal vibrations of various deuterium derivatives were calculated by the use of this potential function and their vibrational frequencies were assigned. The observed frequencies of $CH_3CH_2CD_3$, $CH_3CH_2CH_2D$, and CH_3CHDCH_3 were well elucidated by the results of the calculation. It was shown that the coupling between the CH_3 and the CC-stretching motions is remarkable, and that these frequencies, together with those of the CH_2-rocking motions, can be used as key bands for the analysis of deuterium derivatives. (auth)

12296 ^{17}O NUCLEAR MAGNETIC RESONANCE OF SINGLE CRYSTALS OF D_2O ICE. Waldstein, Peter; Rabideau, Sherman W. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Chem. Phys., 47: 5338-42(Dec. 15, 1967). (LA-DC-8534).

Oxygen-17 NMR spectra were obtained for two orientations of a single crystal of D_2O enriched to 22% in ^{17}O. The spectra of only one orientation could be assigned. This assignment yields quadrupole coupling constants for ^{17}O in ice as follows: $|e^2Qq_{zz}/h| = 1.79 \pm 0.05$ MHz, $\eta = -1.01 \pm 0.04$, where the z axis is the C_2 axis of the D_2O molecule. The isotropic chemical shift is 612 ± 37 ppM paramagnetic to liquid D_2O. (auth)

12297 INVERSE ISOTOPE EFFECT IN DISSOCIATIVE ATTACHMENT OF ELECTRONS IN METHANE. O'Malley, Thomas F. (General Research Corp., Santa Barbara, Calif.). J. Chem. Phys., 47: 5457-8(Dec. 15, 1967).

The inverse isotope effects in dissociative attachment of electrons in methane exemplified by $\sigma_H(CH_4) \simeq 0.8\sigma_D(CD_4)$ are discussed. The inverse isotope effect is the $m^{1/2}$ dependence, which is explicitly predicted by the theory whenever the autoionization width Γ_a of the quasistationary final state of the molecule is small. The $m^{1/2}$ pre-exponential factor which explains the inverse isotope effects is simply a consequence of the normalization of the initial vibrational wavefunction. (D.H.M.)

12298 REGULARITY OF SOLUTIONS OF INNER COMPLEX SALTS. Davila, Aida T. (Philippine Atomic Research Center, Diliman). Philippines Nucl. J., 1: 71-82(Jan. 1967).

The behavior of some typical inner complex salts (chromium(III) acetylacetonate, uranyl oxinate, and uranyl acetylacetonate monohydrate) in common organic solvent was studied. The solvents used were selected with a view of obtaining as wide a range of polarity and internal pressure as was compatible with experimental techniques. These solutions did not meet the exacting demands required for ideal solutions because they involved molecules of different sizes and molecules that interact preferentially with each other. They were examined as to whether their properties would be predictable by the use of Hildebrand's theory of regular solutions as described by the following relationship: $RT \ln a_2/x_2 = v_2\phi_1^2(\delta_1 - \delta_2)^2$. Other related thermodynamic properties of these solutions were estimated by plotting $\log x_2$ against 1/T and by using the following equations: $\Delta F^\circ = -RT \ln K = -2.303\ RT \log K$; $\Delta F^\circ = \Delta H^\circ - T\Delta S^\circ$. Predicting the solubility behavior of these complexes in any solvent of known δ_1, if the relation $\delta_2 = C_2\delta_1$ has been established for at least two solvents at a single temperature, is possible. (auth)

12299 INFRARED SPECTROSCOPY DATA ON THE EXTERNAL INFLUENCE IN URANYL COMPLEXES. Vdovenko, V. M.; Mashirov, L. G.; Skoblo, A. I.; Suglobov, D. N. Zh. Neorg. Khim., 12: 2914-21(Nov. 1967). (In Russian).

The effects of external particles (alkali metal and alkyl ammonium cations, proton and aproton acids) on the internal bonds of complexes were examined on $[UO_2Cl_4]^{2-}$. The observations were made at the frequency of the antisymmetric valence oscillation of $\nu_3UO_2^{2+}$ (from which the multiplicity of the U–Cl bonds and of the effective charge on the external cation was determined). From the data obtained it was established that interaction with the anion uranyl complex is independent of the nature of the external particle and leads to partial transfer of the electron density with the central ion–ligand bond and can be examined in the framework of the donor-acceptor scheme. (tr-auth)

12300 VIBRATIONAL SPECTRA OF NITRATE COMPLEXES OF Th COMPOUNDS. Petrov, K. I.; Molodkin, A. K.; Saralidze, O. D.; Belyakova, Z. V. (Inst. of New Problems in Chemistry, Moscow). Zh. Neorg. Khim., 12: 2974-82(Nov. 1967). (In Russian).

The infrared absorption spectra and Raman scattering spectra of crystalline samples of Th nitrates were investigated. Conclusions were made on the structure of the Th nitrate complexes studied: $Th(NO_3)_4 \cdot 5H_2O$, $Th(NO_3)_4 \cdot 4H_2O$, $Rb_2Th(NO_3)_6$, $Cs_2Th(NO_3)_6$, $NaTh(NO_3)_5 \cdot 8.5H_2O$, $KTh(NO_3)_5 \cdot 6H_2O$, $MgTh(NO_3)_6 \cdot 8H_2O$, $MnTh(NO_3)_6 \cdot 8H_2O$, $NiTh(NO_3)_6 \cdot 8H_2O$, $CoTh(NO_3)_6 \cdot 8H_2O$, and $H_3K_3Th(NO_3)_{10} \cdot 4H_2O$.). Coordination formulas are proposed for the complexes. (tr-auth)

12301 STUDIES OF $ThCl_4$ COMPLEX SOLVATES WITH DIMETHYLFORMAMIDE AND CH_3OH BY THE NMR METHOD. Golub, A. M.; Kalibabchuk, V. A.; Kuts, V. S. Zh. Neorg. Khim., 12: 2983-8(Nov. 1967). (In Russian).

The interaction of $ThCl_4$ with dimethylformamide was studied in acetone solutions by the NMR method. It was established that the composition of the complex formed is $ThCl_4 \cdot 2DMF$. The dissociation constants of the complex solvate in acetone ($4.7 \text{ to } 5 \times 10^{-2}$) were calculated. It was found that DMF is coordinated around Th by the carbonyl group of the acid. The interaction of $ThCl_4$ with methanol was also studied by the NMR method. In acetone solution the formation of the complex solvate $ThCl_4 \cdot 4CH_3OH$ was established and its dissociation constant was calculated as 5.5×10^{-4}. (tr-auth)

12302 THORIUM NITROBENZOATE. Kovalenko, K. N.; Lutsenko, L. V. Zh. Neorg. Khim., 12: 2989-93(Nov. 1967). (In Russian).

The system Th nitrate–Na p-nitrobenzoate–water and Th nitrate–Na o-nitrobenzoate–water were studied. The electroconductivity, pH, and Th concentration in each phase of the system were measured. A chemical analysis of the precipitate was made. It was found that the composition of the compound formed in a system does not depend on the mole ratio of the components (in the limits from 1 : 1 to 1 : 8) and corresponds to the formulas $Th(OH)_2(p\text{-}C_6H_4NO_2COO)_2 \cdot H_2O$ and $Th(OH)_{0.5}(o\text{-}C_6H_4NO_2COO)_{3.5}$. The dependence of the solubility of $Th(OH)_2(p\text{-}C_6H_4NO_2COO)_2 \cdot H_2O$ on the pH of the aqueous medium was established by photocolorimetric analysis with Arsenazo. The presence in the molecule of two OH groups was verified and its solubility product at 22°C was established as 8×10^{-34}. Thermographic analyses were made of the Th p- and o-nitrobenzoates. (tr-auth)

12303 COMPLEX FORMATION OF URANYL ION WITH SULFITE ION. Zakharova, F. A.; Orlova, M. M. Zh. Neorg. Khim., 12: 3016-22(Nov. 1967). (In Russian).

The complex UO_2SO_3 was prepared by the method of potentiometric titration of equimolar mixtures of 1 : 1, 1 : 2, 1 : 3, and 1 : 4 of uranyl nitrate and ammonium bisulfite in KOH solution. Its concentration instability constant was calculated as $K_i = 1.4 \pm 0.1 \times 10^{-6}$. It was verified by the spectrophotometric method that in uranyl nitrate and ammonium bisulfite solutions at $UO_2^{2+} : HSO_3^-$ ratios varying from 1 : 0.5 to 1 : 8 only one complex UO_2SO_3 with the instability constant $9.8 \pm 0.3 \times 10^{-7}$ is formed. The solubility of $UO_2SO_3 \cdot 4.5\ H_2O$ in Na bisulfite solutions was determined. It was established that in the concentration range of the bisulfite from 0.05 to 1.0 mole/l two complexes, UO_2SO_3 and $UO_2(SO_3)_2^{2-}$ exist. From solubility data the instability constant was calculated for the complex $UO_2(SO_3)_2^{2-}$. At $\mu = 1$ it was $4.8 \pm 1.7 \times 10^{-4}$. The total instability for $UO_2(SO_3)_2^{2-}$ was 6.7×10^{-10}. (tr-auth)

12304 INFRARED ABSORPTION SPECTRA AND LUMINESCENCE OF POTASSIUM URANYL SULFATE. Volod'ko, L. V.; Komyak, A. I.; Sleptsov, L. E. (Belorussian State Univ., Minsk). Zh. Neorg. Khim., 12: 3031-4(Nov. 1967). (In Russian).

The infrared spectra at 400 to 3,600 cm^{-1} of $K_2UO_2(SO_4)_2 \cdot 2H_2O$ was obtained at room temperature and the luminescence spectra at 77°K. It was found that in this compound the sulfate group acts as a bidentate ligand. The development of the oscillation frequency of the sulfate group and the coordination waves in the luminescent spectra of the potassium uranyl sulfate was established and the possibilities of using it for analytical purposes were determined. (tr-auth)

12305 KINETICS OF ISOTOPIC EXCHANGE IN Co(III) COORDINATION COMPOUNDS. Chernyaev, I. I.; Ganiev, A. G.; Tukhtaev, Sh. Sh. (Inst. of Nuclear Physics, Tashkent). Zh. Neorg. Khim., 12: 3078-80(Nov. 1967). (In Russian).

On the basis of studies made on Co(III) coordination compounds, the following series was established: $NO_2 > CNS > Br > Cl > H_2O$ where the substituents were arranged successively with respect to the strength of the bonds of the central atom. (tr-auth)

12306 THE SYSTEM OF $NbCl_5$–$NbOCl_3$. Nisel'son, L. A.; Gavrilov, O. R. Zh. Neorg. Khim., 12: 3166-71(Nov. 1967). (In Russian).

Methods for the determination of $NbOCl_3$ and $NbCl_5$ impurities were developed. It was found that $NbCl_5$ purified by rectification contains less than 0.05% $NbOCl_3$. The fusibility diagram of the system $NbCl_5$–$NbOCl_3$ was studied, and it was established that it is a simple eutetic degenerating to pure $NbCl_5$. It was established that at atmospheric pressure on the pure $NbCl_5$ side $\alpha\ NbCl_5/NbOCl_3 = 1.3$. The value obtained for the comparative volatility showed the possibility of complete purification of $NbCl_5$ from $NbOCl_3$ by rectification methods. (tr-auth)

12307 THE SYSTEMS $TaCl_5$–KCl–NaCl–$AlCl_3$ AND $NbCl_5$–KCl–NaCl–$AlCl_3$. Chikanov, N. D.; Dubyanskaya, A. A. (Voronezh State Univ., USSR). Zh. Neorg. Khim., 12: 3187-91(Nov. 1967). (In Russian).

Diagrams of the quaternary systems $TaCl_5$–KCl–NaCl–$AlCl_3$ and $NbCl_5$–KCl–NaCl–$AlCl_3$ were constructed on the basis of composition data. The authenticity of the diagrams was verified by thermal analysis data. (tr-auth)

12308 ACTIVATION ENERGY OF THE HYDRATED ELECTRON + WATER REACTION AND THE ULTRA-VIOLET ABSORPTION SPECTRUM OF THE HYDRATED ELECTRON. Fielden, E. M.; Hart, E. J. (Argonne National Lab., Ill.). Trans. Faraday Soc., 63: 2975-82(Dec. 1967).

The UV absorption spectrum of the hydrated electron was accurately determined down to 2200 Å, where the molar extinction coefficient is 475 $M^{-1}\ cm^{-1}$. A weak absorption with a lifetime of a few microseconds was noted below 3000 Å. This absorption was not due to either the OH, HO_2, or H_2O_2 species produced by the irradiation. The activation energy of the reaction $e^-_{aq} + H_2O \rightarrow H + OH^-$ was determined, by rate measurements over the temperature range 5 to 81°C, as 6.7 ± 0.7 kcal/mole. Combined with other thermodynamic data this value indicates that the reaction has a large negative entropy $\Delta S^{\ddagger}$ of activation of –22 cal/mole deg. (auth) (UK)

12309 AMERICIUM CHLORO-COMPLEXES. Bagnall, K. W.; Laidler, J. B.; Stewart, M. A. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., A: No. 1, 133-6 (1968).

Americium(III) tetrachloro- and hexachloro-complexes, $CsAmCl_4$ (hydrated and anhydrous), $Cs_2NaAmCl_6$, and Cs_3AmCl_6 were prepared. Their infrared spectra and some x-ray powder results are reported; the analyses of these compounds, and of the americium(V) chloro-complex $Cs_3AmO_2Cl_4$ are consistent with the new value (433 years) for the half-life of ^{241}Am. (auth) (UK)

12310 β-DEUTERIUM ISOTOPE EFFECT IN SOLVOLYSIS OF α-PHENYL ETHYL CHLORIDE: THE NATURE OF THE TRANSITION STATE IN SOLVOLYSIS. Guinot, A.; Lamaty, G. (ENSCM, Montpellier, France). Chem. Commun., No. 18, 960-1(1967).

It is stated that the nature of the transition state in solvolysis is controversial. The solvolysis rate of (1-chloroethyl)benzene and (2, 2, 2-$^2H_3$)-α-(1-chloroethyl)benzene were measured in ethanol–water mixtures containing 0 to 10% water (vol %). The ratio of rates k_H/k_D was remarkably constant at about 1.22, whereas a slow and monotonic decrease was expected. It was established that hyperconjugative stabilization of the carbonium ion occurs. The results could not be fitted within the scheme of the "push-pull" mechanism, and it is believed that the sharp increase in isotope effect in water-poor mixtures indicates that: the solvolysis reaction is a competition between a unimolecular and a bimolecular reaction; the bimolecular reaction has a rather high activation energy and plays a significant role only when the "ionising" power of the solvent is unable to promote the breaking of the C–Cl bond, that is, in mixtures containing <5% water; and the transition state nears that of the carbonium ion when the water content of the solvent decreases from 20% to 5%. The nature of the bimolecular reaction remains unanswered, but an interpretation is suggested involving two different reaction paths. (UK)

12311 THERMODYNAMIC CHARACTERISTICS OF INTERMEDIATE TUNGSTATES OF THE TITANIUM SUBGROUP. Amosov, V. M.; Plyushchev, V. E. (Moscow Inst. of Fine Chemical Tech.). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met., No. 5, 97-104(1967). (In Russian).

Evaluations were made of basic thermodynamic characteristics of intermediate tungstates of the elements of the Ti subgroup. The probable values of the enthalpy and entropy of formation were 625 and 58.47, respectively, for $Ti(WO_4)_2$, 664.8 and 60.47 for $Zr(WO_4)_2$, 679.2 and 62.07 for $Hf(WO_4)_2$, and 710.8 kcal/mol and 63.93 enthalpy units for $Th(WO_4)_2$. The temperature dependences of the thermal capacity and the isobar-isotherm potentials of the intermediate tungstates of Ti, Zr, Hf, and Th were determined for the temperature interval from 298°K up to the temperature of the first phase transformation. (tr-auth)

12312 ON THE NATURE OF THE HEXAGONAL SILICIDE OF URANIUM USi_2 AND THE EXISTENCE OF A NEW TERNARY COMPOUND $U_6Si_{11}O$. Blum, Pierre-L.; Laugier, Jean; Morlevat, Jean-Pierre; Vaugoyeau, Henri (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. C, 265: 1328-30(Dec. 6, 1967). (In French).

It is shown that the hexagonal silicide of uranium, until now called USi_2, is, in reality, a ternary compound with the formula $U_6Si_{11}O$, of which the mechanisms of formation by careful oxidation of U_3Si_5 and decomposition under vacuum can be clarified. The existence of a solid solution was established by substitution of oxygen in U_3Si_5, in which the composition at saturation corresponds to $U_3Si_{4.7}O_{0.3}$. (tr-auth)

12313 SPONTANEOUS DECOMPOSITIONS OF ^{131}I AND L-THYROXINE-^{131}I ON CHROMATOGRAPHY PAPER. Hoebel, M. (Univ., Heidelberg). Arch. Pharmakol. Exp. Pathol., 257: 287-8(1967). (In German).

Changes were observed after uv irradiation of chromatograms of aqueous solutions of $Na^{131}I$ at pH 4.5, 5.5, and 7.3. At pH 8.8 drying of chromatographic papers with uv light did not produce reduction of $Na^{131}I$ solutions. Irradiation of L-thyronine-^{131}I on paper chromatograms with uv light produced considerable deiodinization. Even if direct uv irradiation is prevented during the drying periods, variations of the drying times may produce some action on enzymatic organ hydrolysates that contain this I compound. During a drying time of 15 min spontaneous concentration changes of L-thyronine-^{131}I and L-thyroxine-^{131}I may be produced, with the concentrations of I remaining constant. These changes are small, but statistically significant. (BBB)

12314 ISOTOPE EXCHANGE AND EQUILIBRATION REACTION ON NICKEL IN THE SYSTEM DEUTERIUM-LIGHT WATER. Enyo, Michio (Hokkaido Univ., Sapporo). J. Res. Inst. Catal., Hokkaido Univ., 15: 1-20(Sept. 1967).

The exchange reaction between alkaline solution of light water and pure deuterium or gaseous hydrogen containing deuterium on nickel catalysts with and without cathodic polarization was studied. The equilibration reaction between hydrogen and deuterium and the parahydrogen conversion reaction in the same system was also studied. From the observed deuterium exchange rates, change in composition of the gaseous hydrogen, and rates of the hydrogen electrode reaction, the following conclusions were drawn: the hydrogen electrode reaction on nickel in alkaline solution obeys the catalytic mechanism; the equilibration reaction between the gaseous hydrogen isotopes as well as parahydrogen conversion reaction take place rapidly, as side reactions, simultaneously with the exchange reaction; and the Langmuir-Hinshelwood mechanism of the equilibration reaction between adsorbed hydrogen molecules best interprets the experimental results obtained on moderately smooth nickel catalysts. (auth)

12315 INFRARED ABSORPTION OF D_2O IN SOLID NITROGEN. Harvey, K. B.; Shurvell, H. F. (Univ. of British Columbia, Vancouver). J. Mol. Spectrosc., 25: 120-2(Jan. 1968).

The infrared spectra of D_2O in solid nitrogen at liquid helium temperatures were studied. Multiplets in the regions of all three fundamentals of D_2O were observed. Dimers and trimers (or low polymers) were identified on the basis of their broadness, their position relative to the monomer peaks, and their behavior during warm-up and dilution studies. After assignments to polymeric species were made, several sharp peaks in the region of each fundamental remained which might be assigned to nearly freely rotating monomer and to interacting pairs of D_2O molecules in nonnearest neighbor sites. (J.G.B.)

12316 TERNARY OXIDES. VII. TERNARY URANIUM(V) OXIDES WITH MONO- AND DIVALENT CATIONS. Kemmler-Sack, S.; Ruedorff, W. (Univ., Tuebingen, Ger.). Z. Anorg. Allg. Chem., 354: 255-72(Oct. 1967). (In German).

The following complex oxides with pentavalent uranium were prepared: $LiUO_3$ ($LiNbO_3$ structure), $NaUO_3$ ($GdFeO_3$ structure), KUO_3 and $RbUO_3$ (perovskite type), 0.15 $Li_2O \cdot U_2O_5$ (trigonal U_2O_5 structure), CoU_2O_6 and NiU_2O_6 (hexagonal), and the fluorite-type phases 0.5 $Li_2O \cdot U_2O_5$, MgU_2O_6, MnU_2O_6, and CdU_2O_6 with a composition range up to $Cd_2U_2O_7$ and a transition to a pyrochlore-type structure. Further, there are indications for the existence of fluorite-type compounds in the systems $Na_2O \cdot U_2O_5$ and $K_2O \cdot U_2O_5$. Reaction conditions, properties, and lattice constants are discussed. (auth)

12317 TERNARY OXIDES. VIII. TERNARY URANIUM(V) OXIDES WITH TRIVALENT CATIONS. Ruedorff, W.; Erfurth, H.; Kemmler-Sack, S. (Univ., Tuebingen, Ger.). Z. Anorg. Allg. Chem., 354: 273-86(Oct. 1967). (In German).

In the La_2O_3–U_2O_5 system (16 to 60 mol % $LaO_{1.5}$) the following phases are observed: at 16 to 33 mol % $LaO_{1.5}$, U_3O_8 and a (La,

U(V), U(IV)) fluorite phase; 33 to 47 mol % $LaO_{1.5}$, a (La, U(V)) fluorite phase; 50 to 60 mol % $LaO_{1.5}$, a fluorite and a rhombohedral phase. The fluorite-type compounds $ScUO_4$, YUO_4, $NdUO_4$, $SmUO_4$, $EuUO_4$, $GdUO_4$, and $YbUO_4$ were prepared. $BiUO_4$ crystallizes in the fluorite structure (a = 5.481 Å). On the uranium rich region of the $Bi_2O_3-U_3O_8$ system, a (Bi, U(V), U(IV)) fluorite phase and U_3O_8 are formed. With a Bi : U ratio >1 a fluorite phase, bismuth, and Bi_2UO_6 are found. $BiUO_4$ is reduced by UO_2 and with $UO_{2.25}$ a (Bi, U(V), U(IV)) fluorite phase is formed. $FeUO_4$ is isomorphous with $CrUO_4$. The reflectance spectra of the compounds are given. (auth)

12318 TERNARY OXIDES. IX. MAGNETISM OF U(V) IONS IN TERNARY OXIDES. Kemmler-Sack, S.; Stumpp, E.; Ruedorff, W.; Erfurth, H. (Univ., Tuebingen, Ger.). Z. Anorg. Allg. Chem., 354: 287-300(Oct. 1967). (In German).

The magnetic susceptibilities of some ternary uranium(V) oxides were measured. A comparatively small paramagnetism was found, which does not obey the Curie–Weiss law. The susceptibilities may be represented by $\chi_{U^{5+}} = C/T + A$. The temperature independent part A was between 300 and 500×10^{-6}. The Curie constant, C, varied within 0.03 to 0.06 for the coordination number 6 and within 0.12 to 0.18 for the coordination number 8. The magnetic properties of α-U_3O_8 are in accordance with the formula $U_2O_5 \cdot UO_3$. The magnetic behavior of uranium(V) oxides is consistent with that expected for an ion with a ground state configuration f^1 perturbed by spin-orbit coupling and octahedral or cubic ligand fields. (auth)

12319 INFLUENCE OF COMPLEX FORMATION ON THE POLAROGRAPHIC BEHAVIOR OF URANIUM IN SULFURIC ACID SOLUTIONS. Stabrovskii, A. I. Zh. Neorg. Khim., 12: 3311-18(Dec. 1967). (In Russian).

Effects of the addition of gelatin and thymol on the pattern of electrode processes during reduction of the uranium ion on a mercury capillary electrode in sulfuric acid solution were investigated. The optimum concentration at which only depression of the polarographic maximum occurred was equal to 0.0025% for gelatin and 0.0005% for thymol. The change of concentration of the sulfuric acid affected not only the height of the U(VI) reduction wave but the size of the potential half-wave. At a pH of 1.7 or less the uranium(IV) in the sulfuric acid solution is in the form of the elementary ions U^{4+}, and at a pH of 2.55 only 50% of the U(IV) is converted into the hydrolyzed ion form $[U(OH)_2]^{2+}$; ions of U(IV), subjected to hydrolysis, lose the capacity of being reduced on the capillary electrode but can be oxidized. The effect of the complex formation of uranyl ions and U(IV) with sulfate ions in electrode processes, proceeding during reduction of uranium compounds on the capillary electrode in solution, was investigated. With increasing concentration of the sulfate ions in the solution the potential half-waves of the first, second, and third reduction of U(VI) became more negative. (tr-auth)

12320 SOLUBILITY PRODUCT OF URANYL PHOSPHATE. COMPOSITION AND DISSOCIATION CONSTANTS OF URANYL PHOSPHATE COMPLEXES. Moskvin, A. I.; Shelyakina, A. M.; Perminov, P. S. Zh. Neorg. Khim., 12: 3319-25(Dec. 1967). (In Russian).

Concentration and temperature effects on the solubility constant of $UO_2HPO_4 \cdot 4H_2O$ were calculated at 25, 50, and 70°C. The solubility of $UO_2HPO_4 \cdot 4H_2O$ in 0.5 mol HNO_3 in the presence of phosphoric acid of different concentrations was determined. Under these conditions the complexes $[UO_2HPO_4]^0$ and $[UO_2(HPO_4)_2]^{2-}$ were formed. The instability constants were, respectively, $\beta_1 = 1.5 \times 10^7$, $\beta_2 = 2.0 \times 10^{17}$ at $\mu = 0.5$ and $\beta_1 = 2.7 \times 10^8$, $\beta_2 = 3.7 \times 10^{18}$ at $\mu = 0.0$. (tr-auth)

12321 CHLORINE ISOTOPIC EXCHANGE OF ORGANIC COMPOUNDS. II. HEXACHLOROPROPENE AND $AlCl_3$-^{36}Cl. Boberg, Friedrich; Kirchhoff, Klaus; Schultze, Georg Richard (Institut fuer Erdoelforschung, Hanover). J. Label. Compounds, 3: 293-310(Oct.-Dec. 1967). (In German).

The exchange of chlorine between hexachloropropene and aluminum chloride-^{36}Cl was investigated. Exchange in the chloroolefin occurred in the 1-, 2-, and 3-positions, depending upon the conditions of reaction. With dichloromethane in homogenous solution, the exchange took place in the 1- and 3-positions. This reaction followed a carbonium-ion mechanism which is discussed in detail. The exchange was inhibited by electron donors in accordance with the concept presented. Preliminary experiments in this direction using furane, tetrahydrofurane, dioxane, and tetrahydropyrane are reported. Mass spectroscopic evidence also favors the hypothesis of carbonium-ion formation. With solid crystals of aluminum chloride, the chlorine atom was additionally exchanged in the 2-position of the chloroolefin. The position of the ^{36}Cl-atoms within the labeled hexachloropropenes was determined by converting the chloroolefin into trichloro-acrylicacid-^{36}Cl. The preparation of $AlCl_3$-^{36}Cl, hexachloropropene-^{36}Cl, and trichloroacrylicacid-^{36}Cl is discussed. The device for producing $AlCl_3$-^{36}Cl from aluminum and HCl-^{36}Cl is described. Activities were measured using liquid scintillation apparatus and a G-M-counter. (auth)

12322 SECONDARY DEUTERIUM ISOTOPE EFFECT UPON THE UNIMOLECULAR DEHYDROCHLORINATION OF t-BUTYL CHLORIDE IN ACETONITRILE. Kevill, D. N.; Dorsey, J. E. (Northern Illinois Univ., De Kalb). Chem. Ind. (London), No. 52, 2174-5(Dec. 30, 1967).

The rate of pyridinium ion formation from the dehydrochlorination of t-butyl chloride and t-butyl chloride-d_9, in acetonitrile at 45°C, in the presence of various concentrations of pyridine, was determined. The development of pyridinium chloride, rather than HCl, prevents the strong reversal of dehydrohalogenation that is observed in aprotic solvents. The pyridinium ion was titrated, in cold acetone, against sodium methoxide in methanol, using resorcinol blue as indicator. The mean first-order rate coefficient for pyridinium ion formation was $(2.658 \pm 0.014) \times 10^{-6}$ sec^{-1} for the non-deuterated system, and $1.013 \pm 0.007 \times 10^{-6}$ sec^{-1} for the deuterated system. The isotope effect was therefore 2.624 ± 0.023, a value somewhat greater than 2.22 calculated for 50 : 50 ethanol–water at the same temperature. (UK)

12323 HYDROGEN ISOTOPE EXCHANGE IN METHYLQUINONES. Clark, V. M.; Hutchinson, D. W.; Wilson, R. G. (Univ. of Warwick, Coventry, Eng.). Chem. Commun., No. 1, 52-3(1968).

Studies are reported on the base-catalyzed incorporation of deuterium and tritium into methyl quinones, providing evidence for intermediate anions of the quinone methide type. Duroquinone, after heating under reflux for several hours in dioxan–D_2O with triethylamine or K_2CO_3, was found to contain deuterium. Using tritiated water it was possible to determine the degree of isotope incorporation. With triethylamine and 2,3-dimethylnaphthaquinone isotopic equilibrium was reached after 10 hr under reflux in aqueous dioxan. Isotope incorporation was found to be greatly dependent on the nature of the base, the temperature, and the apparent pH; the reaction rate and products were also very sensitive to change in the type of base. Biological considerations concerned with the oxidative phosphorylation associated with electron transport in bacteria and mitochondria are briefly discussed. (UK)

12324 σ-PARTICIPATION AND SECONDARY DEUTERIUM ISOTOPE EFFECTS: THE NORBORNYL CASE. Jerkunica, J. M.; Boricic, S.; Sunko, D. E. (Univ., Zagreb). Chem. Commun., No. 24, 1302-4(1967).

The interesting, but controversial, proposal of C–C σ-bond participation in the solvolysis of exo-2-norbornyl derivatives, as opposed to a nonparticipating path for the endo-isomer, led to a study of secondary kinetic isotope effects in specifically deuterated 2-norbornyl derivatives. A significant γ-isotope effect was observed in the exo-2,6-dideuterio series, but such an effect was absent in the endo-series. The β-isotope effect was determined in two isomeric 3,3-dideuterio-norbornyl derivatives under conditions comparable to those used with the 6-deuterio compounds. Exo- and endo-3,3-dideuterio-2-norbornyl p-bromobenzenesulphonates were prepared and solvolyzed in glacial acetic acid, the reaction rate being followed. In accordance with predictions, only the exo-compound showed a significantly reduced β-effect, while the rate retardation in the endo-compound was of the expected magnitude for unassisted solvolysis. These results are briefly discussed. (UK)

12325 THE PROTONATION OF NITROALKANE ANIONS BY ACETIC ACID IN MIXED H_2O–D_2O SOLVENTS. Goodall, D. M.; Long, F. A. (Cornell Univ., Ithaca, N. Y.). J. Amer. Chem. Soc., 90: 238-43(Jan. 17, 1968).

The rates of protonation of the anions of nitromethane and nitroethane by acetic acid were measured in mixed H_2O–D_2O solvents at 25°C. These are combined with earlier results of Reitz for the reverse reaction and analyzed using generalized Gross–Butler equations. Use of such equations with neglect of the medium effect cannot account for the data. Most of the contributions to this isotope effect on solvation can be measured independently. The ratio of degenerate activity coefficients for transfer of chloride and acetate ions from light to heavy water is needed, and the value $\gamma_{Cl^-}/\gamma_{Ac^-} = 1.19$ was found via emf measurements on the silver salts. The influence of chloride, acetate, and nitroalkane anions on the structure of water is discussed. Fractionation factors for the transition states are in good agreement with those calculated from isotope effects in the reverse reactions. A transition state involving direct proton transfer between acid and base is consistent with all the data, whereas one with transfer via a water bridge is incompatible. (auth)

12326 EFFECTS OF DEUTERIUM SUBSTITUTION ON THE RATES OF ORGANIC REACTIONS. XI. α- AND β-DEUTERIUM EFFECTS ON THE SOLVOLYSIS RATES OF A SERIES OF SUBSTITUTED 1-PHENYLETHYL HALIDES. Shiner, V. J. Jr.; Buddenbaum, W. E.; Murr, B. L.; Lamaty, G. (Indiana Univ., Bloomington). Contract AT(11-1)-1008. J. Amer. Chem. Soc., 90: 418-26(Jan. 17, 1968). (COO-1008-2).

The rates of solvolysis of eight different meta- and para-substituted 1-phenylethyl chlorides, three 1-phenylethyl bromides, and their α-d and β-d_3 analogs were measured in a series of acetone–water and ethanol–water mixtures with a precision of 0.1% or better using conductance techniques. The fact that 1-phenylethyl chloride and all of its more reactive derivatives, including the p-methoxy compound, have closely similar α-deuterium effects ($k_H/k_D = 1.15$) is interpreted in terms of a limiting carbonium ion mechanism applying for all of these compounds. The smaller α effects for the m-bromo (1.13) and p-nitro (1.11) derivatives are believed to indicate that these solvolyses involve appreciable nucleophilic character. The fact that the three bromides examined show α-d effects that are about 3% smaller than those of the corresponding chlorides is believed to be due to the HCBr bending force constant being smaller than the HCCl bending force constant in the initial state. The similarity in the influence of substituents indicates that the solvolytic mechanisms for bromides and chlorides are similar. Increasingly electron-releasing substituents in the ring were found to be associated with increasingly smaller β-d effects for all compounds more reactive than 1-phenylethyl chloride. The substituents and approximate $k_H/k_{\beta D_3}$ effects were H (1.22), m-CH_3 (1.22), p-F (1.21), p-CH_3 (1.20), p-phenoxy (1.16), and p-methoxy (1.11). This trend was attributed to the electron-releasing substituents raising electron density at the reaction center and reducing the demand for hyperconjugation from the β-CH_3 (or CD_3) group. Thus, this result confirms earlier conclusions that the β-deuterium effect on the rate of carbonium ion forming reactions depends in major part on a hyperconjugative mechanism of interaction between the reaction center and the site of isotopic substitution. The smaller than otherwise expected β-d_3 effects for the m-bromo (1.22) and p-nitro (1.20) α-phenylethyl chlorides are in accord with the conclusion that these compounds react in part at least by a nucleophilic mechanism. The β-deuterium effects for the α-phenylethyl bromides are very near those for the corresponding chlorides in agreement with the conclusion that chlorides and bromides react by very similar mechanisms and that the difference in α effects is due primarily to the HCX bending force constant difference in the initial state. (auth)

12327 EXCHANGE REACTIONS OF CARBOXYLIC ACID SALTS. A FACILE PREPARATION OF α-DEUTERIOCARBOXYLIC ACIDS. Atkinson, J. G.; Csakvary, J. J.; Herbert, G. T.; Stuart, R. S. (Merck Sharp and Dohme of Canada Ltd., Montreal). J. Amer. Chem. Soc., 90: 498-9(Jan. 17, 1968).

The exchange reaction of carboxylic acid with D_2O was investigated. Refluxing a concentrated solution of sodium or potassium acetate in basic deuterium oxide caused the ready exchange of the protons of the methyl group with a half-life of 3 to 5 hrs. The reaction was quite general and provided a simple one-step preparation of a wide variety of α-deuteriocarboxylic acids. Since aliphatic substitution on the α-carbon of acetic acid slowed the exchange rate severalfold, the exchange for the higher acids was run in a stainless steel bomb at 150°C. The extent and location of deuteration were determined by NMR. In no case was there evidence for exchange at any but the α (or vinylogously α) carbon atom. Several aliphatic monocarboxylic acids, aliphatic dicarboxylic acids, arylacetic acids, α,β-unsaturated carboxylic acids, and toluic acids were exchanged. (D.H.M.)

12328 INTERMOLECULAR ^{13}C KINETIC ISOTOPE EFFECT IN THE THERMAL STRUCTURAL ISOMERIZATION OF CYCLOPROPANE. Sims, Leslie Berl. Urbana, Ill., Univ. of Illinois, 1967. 229p.

Thesis.

The ^{13}C intermolecular kinetic isotope effect in the unimolecular structural isomerization of cyclopropane to propylene was investigated from 700 to 1 mm Hg pressure at four temperatures: 513.8, 494.9, 474.0, and 450.3°C. A sample of purified commercial cyclopropane containing natural abundance ^{13}C was isomerized for a predetermined time and the reaction quenched. The products of the isomerization (propylene and unreacted cyclopropane) were separated by gas chromatography and the fraction of reaction determined. The rate constant ratio k/k' for the reactions cyclo-$^{12}C_3H_6 \xrightarrow{k}$ propylene ($^{12}C_3H_6$) and cyclo-$^{12}C_2{}^{13}CH_6 \xrightarrow{k'}$ propylene ($^{12}C_2{}^{13}CH_6$) was determined from the isotopic content ($R = {}^{12}C_2{}^{13}CH_6/{}^{12}C_3H_6$) of product propylene ($R_B$) and unreacted cyclopropane (R_A) at a given fraction of reaction f. The isotopic ratios R_B and R_A were determined. A sample of propylene (or cyclopropane) was oxidized over copper oxide to CO_2 and H_2O, the CO_2 was dried and purified, and the $^{13}CO_2/^{12}CO_2$ molar ratio determined by isotope-ratio mass spectrometry. The limiting high pressure rate constant ratio was given adequately by $k/k' = 0.997 \exp[(17.5 \pm 1.0)/RT]$ over the experimental temperature interval. The value for k/k' decreased with pressure below about 100 mm Hg (from 1.0080 ± 0.0001 at high pressures to 1.0022 ± 0.0001 at 1 mm pressure at 513.8°C, for example). Below 100 mm pressure, the decline of k/k' was nearly linear with log (pressure). Comparisons of the results are made with classical versions of the Hinshelwood, Kassel, and Slater theories of unimolecular reactions, and with the more recent quantum statistical theory of Marcus. Quantitative agreement between the observed ^{13}C isotope effect and that calculated from the classical theories can be achieved (except in the case of the simple Hinshelwood theory) only if the classical fall-off parameters are allowed to assume non-integral, and hence not physically meaningful, values. Calculations made using the Marcus theory reveal that the calculated ^{13}C kinetic isotope effect (k/k') is more sensitive to the vibrational frequency pattern assumed for the complex than either the calculated isomerization rate constant (k) or the calculated deuterium isotope effect (k_H/k_D), and that k/k' is most sensitive to just those frequencies of the complex (notably those frequencies derived from the ring deformation frequencies of cyclopropane) to which the calculated deuterium isotope effect is least sensitive. It was possible to fix most of the frequencies of the complex within rather narrow limits by requiring that the complex used in the Marcus theory calculations give satisfactory agreement with all of the major experimental results on the isomerization of cyclopropane, including the ^{13}C kinetic isotope effect results. Further refinement of the complex frequency pattern could be made by making small changes of a few wave numbers in some of the frequencies of the isotopic complex to improve agreement between the calculated and experimental ^{13}C isotope effect, particularly the pressure dependence of the rate constant ratio. The nature of the changes required to improve the agreement with the ^{13}C isotope effect while retaining or improving agreement with the other experimental quantities was investigated. (Disser. Abstr.)

12329 QUANTUM MECHANICAL CALCULATIONS OF REACTION PROBABILITIES OF THREE-BODY EXCHANGE REACTIONS. Oref, Izhack. Santa Barbara, Calif., Univ. of California, 1967. 111p.

Thesis.

Quantum mechanical calculations were performed on the reaction probabilities of linearly constrained systems. The transmission coefficients of the reaction AB + C → A + BC, where AB is a diatomic molecule and C is an atom, were calculated for a variety of initial conditions and potential surfaces. Calculations of the vibrational energies of the complex ABC revealed that only a small portion of the vibrational energy of the reactant diatomic molecule is available for crossing the barrier. The wavefunctions and the probability density functions, $|R|^2 r$, of the complex indicated that at low total energy the reaction path is confined to large interatomic distances within the complex. At high energies the reverse is true and the reaction path is confined mainly to small interatomic distances within the complex. The rate constant of the reaction H + D_2 → HD + D was calculated for a variety of potential surfaces and compared with experimental results. The method used in the calculations of the transmission coefficients provides new insight into the nature of the reaction complex, and the energy distribution in it. (Disser. Abstr.)

12330 SOME OBSERVATIONS ON THE CHEMICAL BEHAVIOR OF CARRIER-FREE ^{131}I AND DILUTE CARRIER ^{127}I. Reynolds, Manning S. Albuquerque, N. Mex., Univ. of New Mexico, 1967. 185p.

Thesis.

Unexpected behavior by very small amounts of iodine was noted by biochemical, medical, and ecological workers. It also was shown that mild oxidation of carrier-free ^{131}I-iodide produced previously unknown species of iodine compounds. While studying the formation of carrier-free iodate-131 by perchloric acid oxidation of iodide-131 at elevated temperatures, it was found that the acid is not directly responsible for the formation of iodate. Instead, the oxidation is accomplished by a volatile material (thought to be ClO_2) formed only in perchloric acid more concentrated than the hydrate, $HClO_4 \cdot 3H_2O$. This observation led to the development of a method for generating small amounts of ClO_2 for direct use as an oxidant. The gas was applied in a N_2 gas stream to small volumes of carrier-free iodide-131 solutions during evaporation to dryness at 95°C. The residue, redissolved in distilled water, provides a carrier-free iodate-131 solution free of other forms of iodine and macro amounts of other materials. Increasing perchloric acid concentrations resulted in increased rate and degree of decomposition; the relative yield

of decomposition products (for the most part, "unidentified" species) may also be a function of the acidity. However, with 0.1M Cl^- in solution, most of the non-iodate activity appeared to be iodide. Reduction of the iodate-131 by dilute sulfite solutions also yielded iodide-131. Reduction by a 0.005M Fe^{3+}/0.05M Fe^{2+} redox couple in 1.0M $HClO_4$ led to results predictable from the known chemistry of I_2, provided that the total (carrier) iodate concentration was 10^{-5}M or greater. In more dilute solutions, at least two "unidentified" species appeared in increased percentages as the carrier iodate concentration was decreased. Experiments to determine the coprecipitation behavior of carrier-free iodate-131 with silver halides demonstrated only surface adsorption, and only in the presence of excess Ag^+. A complete range of carrying behavior was found with homologous calcium, barium, and lead carbonates. Ferric hydroxide carried 98% of the activity in the pH range 4.5 to 6.5, whether the precipitate was preformed or formed in the presence of the iodate-131. Silver bromate, and silver and lead periodates carried the iodate-131 very strongly whether precipitated in the presence of excess anion or cation. Carrier-free iodate-131 had little tendency to form radiocolloids. Paper chromatographic techniques for analysis of carrier-free ^{131}I solutions were investigated in some detail and found to be unreliable. Large and variable percentages of iodine were lost from the papers during the chromatographic process, and results were frequently at wide variance with data obtained by an established, chemically milder, solvent extraction-isotopic exchange procedure. (Disser. Abstr.)

12331 ANATION AND WATER EXCHANGE OF AQUOPENTAMMINECHROMIUM(III) ION. Duffy, Norman Vincent Jr. Washington, D. C., Georgetown Univ., 1966. 190p.
Thesis.

The anation of aquopentamminechromium(III) ion by Cl^- and by SCN^- in acidic aqueous solution in $NaClO_4$ media was studied by spectrophotometric methods. At ionic strength 0.106 at 45°C, the second-order rate constants for the reaction with SCN^- and Cl^- were 2.0×10^{-2} min^{-1} $mole^{-1}$ and 3.7×10^{-3} min^{-1} $mole^{-1}$, respectively, and at 1.71M total salt concentration, 7.0×10^{-3} min^{-1} $mole^{-1}$ and 1.3×10^{-3} min^{-1} $mole^{-1}$, respectively. The activation energies, E_a, and activation entropies, $S^\ddagger$, of these reactions were determined on the basis of rate studies at 30, 45, and 60°C; for SCN^-, ionic strength 0.106, $E_a = 24.8 \pm 2.1$ kcal $mole^{-1}$; $S^\ddagger = +3$ eu; for Cl^-, ionic strength 0.106, $E_a = 27.2 \pm 1.1$ kcal $mole^{-1}$, $S^\ddagger = +7$ eu; for SCN^-, total salt concentration 1.71M with NaBr, $E_a = 21.8 \pm 0.3$ kcal $mole^{-1}$, $S^\ddagger = -9$ eu, and for Cl^-, total salt concentration 1.71M with $NaClO_4$, $E_a = 26.2 \pm 0.4$ kcal $mole^{-1}$, $S^\ddagger = +2$ eu. The reaction with SCN^- ion at ionic strength 0.106 was independent of pH from pH 1 to 2. The ion pair association between aquopentamminechromium (III) ion and SCN^- and Cl^- was studied by spectrophotometric methods in the uv region of the absorption spectrum at 23.3°C at ionic strength 0.158. Thiocyanate ion formed a more stable ion pair than Cl^-, the ion pair association constant being 10 ± 4 for SCN^- and 2 ± 1 for Cl^- on the basis of fitted functions. Corresponding changes in molar absorptivities (ΔA) were 94(255 mμ), 61(260 mμ), and 45(265 mμ) for SCN^-, and 129(216 mμ), 285(218 mμ), and greater than 100(220 mμ) for Cl^-. The rate of $H_2{}^{18}O$ exchange of aquopentamminechromium(III) ion at pH 1 at 30°C was 6.9×10^{-3} min^{-1} at ionic strength 0.106, 5.4×10^{-3} min^{-1} at 1.71M total salt concentration in $HClO_4$–$NaClO_4$ media, and 6.9×10^{-3} min^{-1} at 1.71M total salt concentration in HBr–NaBr media. The rate was essentially independent of added Cl^-, SCN^-, or Br^-, and increased with increasing pH at 30°C and ionic strength 0.106: 6.9×10^{-3} min^{-1} at pH 1.25, 1.7×10^{-2} min^{-1} at pH 2.19, and 3.6×10^{-2} min^{-1} at pH 4.08. These data were not fitted by a rate law of the form $(k + k'/(H^+))$. The water exchange reactions were studied at 15 and 45°C and the activation energies at ionic strength 0.106, at total salt concentration 1.71M in $HClO_4$–$NaClO_4$ media, and at total salt concentration 1.71M in HBr–NaBr media were 22 ± 4, 23 ± 5, and 20 ± 4 kcal $mole^{-1}$, respectively. At 45°C, the rate of anation at SCN^- and Cl^- concentrations of up to 1.7M was observed not to exceed the rate of water exchange and no substantial deviations from first-order dependence on entering anion concentration were observed. The data for the substitution reactions are discussed on the basis of a mechanism in which the rate determining step is the unimolecular dissociation of the coordinated water molecule of aquopentamminechromium (III) ion followed by a collapse of the solvation shell of the cation. (Disser. Abstr.)

12332 UNIQUE FORCE CONSTANTS FROM SPECTRA OF TRIATOMIC MOLECULES AND DIHALOMETHANES. Dennen, Robert S. Chicago, Illinois Inst. of Tech., 1967. 251p.
Thesis.

Two factors affecting the validity of the force constant calculations were considered. First, the validity of calculating force constants from observed wave numbers rather than from zero-order wave numbers was examined for a diatomic molecule using a Morse potential energy function. Errors up to about 3% may result from using the observed wave numbers. Second, the uniqueness of the force constants was examined in calculations for which there are more force constants than there are normal modes and calculations that involve a redundant coordinate. The uniqueness of force constants was examined first for several nonlinear, symmetrical XY_2 molecules. For these molecules, there is one more force constant in the most general quadratic potential energy function than there are normal modes. For each XY_2 molecule, it was found that an infinite number of sets of force constants, for each of which there is exact agreement between the observed and calculated wave numbers, may be calculated. Two of the sets have the special feature that they closely reproduce the observed wave numbers for all of the isotopes. These two correspond to the maximum and minimum values of the X-Y stretching force constant f_d, which for H_2O and D_2O are 8.428 and 5.050 mdyn/Å. The value 8.428 leads to a somewhat better agreement with earlier calculations of Dennison. For each XY_2 molecule, the set corresponding to the minimum value of f_d was characterized by large interaction force constants and the symmetrical normal modes are found to have directions of motion which are contrary to the generally accepted interpretations. For each XY_2 molecule the valid set was that which included the maximum allowable value of f_d. This conclusion indicates that it is possible to determine the force constants uniquely from the spectral data of only one isotope. The dihalomethanes were chosen for investigation to determine if the conclusions for triatomic molecules could be extended to larger molecules because they have the same symmetry elements as the triatomic molecules already considered and because of the availability of the results of previous investigations for these molecules. Again (as for the XY_2 molecules), in order to investigate the uniqueness of the force constants, it was essential to know the fundamental wave numbers for several isotopes of each dihalomethane. All of the fundamentals were previously observed for the dichloromethanes but only a few fundamentals were observed for the dibromomethanes. Therefore, a study of both the Raman and infrared spectra was necessary for the dibromomethanes. All of the fundamentals were observed for CH_2Br_2, CD_2Br_2, and $CHDBr_2$. For the dihalomethanes, it was found that, because of the angular redundancy, only 5 valence force constants, the bond stretches and their interactions could be determined uniquely and that the trends in these corresponded to trends in the electronegativities of the atoms W in the bonds C–W (W = H, D, F, Cl, Br, or I). (Disser. Abstr.)

12333 POROUS CARBON SOLIDS. Bond, R. L. (ed.). London, Academic Press, 1967. 322p. 80s.

The problems of characterising or defining the structure of porous carbonaceous solids for particular applications (including nuclear) are discussed. Information on the following subjects is included: usefulness of measurements of physical adsorption of gases in characterising carbons; use of absorption from solution in examining porous carbons; use of molecular probes in characterization of carbonaceous materials; permeability and flow studies; techniques for the study of pore structure by liquid metal penetration; mercury porosimetry and allied techniques; studies of macroporosity of carbons by use of silver impregnation and soft X-rays; and radiographic techniques applied to carbons. (UK)

12334 HALOGEN CHEMISTRY. VOL. III. Gutmann, V. (ed.). London, Academic Press, 1967. 485p. 115s.

Review articles on the following subjects are included: halides containing multicenter metal–metal bonds; the nature of metal–halogen bonds; review of metal–halogen vibrational frequencies; the halides of niobium and tantalum; pentahalides of the transition metals; halide chemistry of chromium, molybdenum, and tungsten; the halogen chemistry of the actinides; and halogeno metal carbonyls and related compounds. (UK)

12335 ELECTRON SPIN RESONANCE IN CHEMISTRY. Ayscough, P. D. London, Methuen, 1967. 468p. 84s.

The subject is reviewed under the following main headings: basic theory–g-factors; nuclear hyperfine structure; relaxation processes and line widths; experimental aspects; transition metal ions; radicals in single crystals; radicals and ions in solution; radicals in polycrystalline and amorphous matrices; F-centers, conduction electrons and semiconductors; biradicals, triplet state molecules and molecular complexes; paramagnetic species in biological systems. (UK)

Radiation and Nuclear Chemistry

Refer also to abstract 12817.

12336 (AERE-R-3428) THE RADIATION INDUCED POLYMERISATION OF VINYL ACETATE. PART I. POLYMERISA-

TION OF PURE MONOMER. PART II. POLYMERISATION IN N-HEXANE. Hill, M. R. H.; Vale, R. L. (Atomic Energy Research Establishment, Harwell (England)). July 1960. 18p. Dep. CFSTI. UK.

The radioinduced polymerization of vinyl acetate using ^{60}Co γ radiation was measured at various dose rates, and temperatures ranging from 25 to 60°C. The rate of polymerization is proportional to the square root of the intensity of the radiation. The polymerization was also studied in n-hexane, a precipitant for poly(vinyl acetate). The addition of nonionic surfactants did not prevent precipitation as the polymerization proceeded and it was not possible to obtain a stable emulsified system. (auth)

12337 (COO-1116-6) KINETICS OF IONIZING RADIATION INDUCED REACTIONS IN ORGANIC COMPOUNDS. Progress Report, August 1, 1966-July 30, 1967. Firestone, Richard F. (Ohio State Univ. Research Foundation, Columbus). Aug. 11, 1967. Contract AT(11-1)-1116. 28p. Dep. CFSTI.

Effects of temperature and the presence of air on the x-radiolysis of gaseous chloroform were studied. The dose dependence of yields of major products from radiolysis of n-pentane was determined. Pulse radiolysis of chloroform and chloroform solutions of aromatic compounds was studied. Yields of solvated electrons were determined in irradiated alcohol solutions of alkali metal halides. The formation and decay of the triplet state of biphenyl formed by the pulse radiolysis of biphenyl-acetone solutions were investigated. (M.C.G.)

12338 (COO-1167-3) TECHNICAL PROGRESS REPORT ON NUCLEAR CHEMISTRY RESEARCH, DECEMBER 15, 1966-DECEMBER 15, 1967. Sugarman, Nathan; Turkevich, Anthony (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies). Contract AT(11-1)-1167. 8p. Dep. CFSTI.

Research progress is reported on: radionuclide production cross sections in Cu with protons at 90 to 440 MeV, radiochemical analysis of freshly fallen meteorites, meson spallation of Cu, recoil properties of isobaric nuclides, recoil studies of isomeric nuclides, evidence of a (p,pα) cascade reaction, and activation analysis for heavy elements in meteorites. (M.C.G.)

12339 (COO-1620-2) CHEMICAL EFFECTS OF THE NUCLEAR REACTION $^{14}N(n,p)^{14}C$ IN VARIOUS NITROGENOUS COMPOUNDS. Progress Report, May 1, 1967-April 30, 1968. Vaughan, John D. (Colorado State Univ., Fort Collins. Dept. of Chemistry). Jan. 15, 1968. Contract AT(11-1)-1620. 12p. Dep. CFSTI.

The detailed chemistry of recoil ^{14}C in crystalline compounds of nitrogen is being studied. Targets include alkali azides, hydrazine dihydrochloride, and certain nitrogen heterocycles. Procedures for assay of recoil carbon products are described. (M.C.G.)

12340 (NYO-2668-15) PRIMARY CHEMICAL PROCESSES IN THE RADIOLYSIS OF LIQUIDS. Final Progress Report, September 15, 1960-September 14, 1967. Trumbore, C. N. (Delaware Univ., Newark. Dept. of Chemistry). Jan. 15, 1968. Contract AT(30-1)-2668. 17p. Dep. CFSTI.

A summary of important research results and publications is given along with administrative details of the past contract year. Significant correlations have been made between product quenching rate constants in the photolysis and radiolysis of several liquid organic systems containing cyclopentanone, thus demonstrating the importance of excited states as radiolytic intermediates in the radiation chemistry of liquid organic compounds. An isotopic exchange reaction study showed the importance of unusual oxidation states of iodine produced by self radiolysis. A new and convenient system has been developed for studying relative rate constants of OH radicals with solutes in aqueous solutions. Unusual results in acid solutions of this system, oxygenated aqueous solutions of p-nitrosodimethylaniline, have caused speculation that there is another oxidizing species besides the OH radical or that there is a precursor to this radical in these acidic solutions. Pulse radiolysis studies using 20-nsec x-ray pulses have demonstrated an unusually fast decay of what is assumed to be the hydrated electron. This fast decay is very efficiently quenched by the addition of small quantities of added bromide ion. Arguments regarding the importance of structure of liquid water in radiation chemistry have been advanced because of these results. (auth)

12341 (ORO-3519-2) RADIATION CHEMISTRY OF MONO-SUBSTITUTED AROMATIC COMPOUNDS. Progress Report, January 15, 1967-January 15, 1968. Knight, J. A. Jr. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract AT(40-1)-3519. 14p. Dep. CFSTI.

The radiation chemistry of some mono-substituted benzenes with both electron-releasing and electron-attracting nonhydrocarbon substituents was investigated. Nitrobenzene and aniline were selected for the initial studies. Gas chromatography is the main analytical technique being used to identify the radiolytic products. Ratios of the relative reactivities of ortho, meta, and para positions of nitrobenzene related to the formation of dinitrobenzenes and nitrobiphenyls during radiolysis were obtained. These data were in accord with the general observations that in homolytic substitution of a mono-substituted benzene, all available positions are attacked and that ortho-para substitution is favored over meta substitution. The sensitivity of the nitroarene bond to radiolytic scission was about 1.5 to 3 times that of the C-H bonds of nitrobenzene. (M.C.G.)

12342 (JPRS-44045) SYNTHESIS OF KURCHATOVIUM. Flerov, G. N. Translated from Priroda, 57: No. 11, 35-44(1967). 22p. CFSTI.

The history of the synthesis of transuranium elements is reviewed. For production of element 104 a plutonium target on an aluminum backing with 2 mg/cm² of the ^{242}Pu isotope was introduced into the cyclotron, where the target was irradiated by the inner beam of ^{22}Ne ions. In the first tests, spontaneously fissioning nuclei with a half-life of about 0.014 sec were recorded. Additional experiments indicated that the observed half-life does not belong to element 104 but to ^{242}Am. As a result of lengthy irradiations fission fragments were observed and the half-life of the emitter was calculated as ~0.3 sec. In more than 1000 hr of irradiation 15 nuclei undergoing spontaneous fission with a half-life of about 0.3 sec were recorded. It was concluded that these were nuclei of element 104. Methods for chemical identification are discussed and tests indicating an element close to hafnium in its chemical properties and differing sharply from the heavy actinide elements are described. (M.C.G.)

12343 (JPRS-44048) SOVIET RESEARCH IN HIGH-ENERGY CHEMISTRY. Translated from Khim. Vys. Energ., 1: 515-23 (1967). 14p. CFSTI.

Progress made in radiation chemistry, photochemistry, plasma chemistry, studies of chemical reactions in shock waves, chemistry of the ionosphere, and nuclear chemistry is reviewed. (M.C.G.)

12344 (NSJ-tr-92) USE OF ^{85}Kr RADIATION SOURCE FOR CHEMICAL REACTION IN LIQUID PHASE. Kasamatsu, Tomomichi; Otsuka, Norikatsu. Translated for Japan Atomic Energy Research Inst., Tokyo, from Oyo Butsuri, 35: 423-9(1966). 17p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

An abstract prepared from the original language version of this paper appeared as NSA 20: 45741. (M.C.G.)

12345 γ-RADIOLYSIS OF CYCLOHEXANE WITH ELECTRON SCAVENGERS. II. SOLID CYCLOHEXANE AT 77°K. Sagert, N. H. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 46: 89-93(Jan. 15, 1968). (AECL-2981).

The γ-radiolysis of homogeneous solid solutions of SF_6 and N_2O in cyclohexane was examined at 77°K. With SF_6, yields of the major products, hydrogen, bicyclohexyl, and cyclohexene, were all reduced, and no large yields of other products were observed. Thus, since SF_6 reduces hydrogen yields by capturing electrons, combination of the SF_6 anion and cyclohexane cation does not lead to bond breaking. Experimental evidence suggests that the ratio of disproportionation to combination of cyclohexyl radicals in solid cyclohexane at ~186°K is 0.3 ± 0.2. With N_2O, hydrogen yields are decreased to 3.5 G units, but large yields of cyclohexene, bicyclohexyl, and cyclohexanol (4.7, 2.0, and 1.0 G units, respectively) are produced. Thus combination of O^- and the cyclohexane cation leads to a great deal of bond breaking. The yields are explained by a mechanism similar to Dyne's mechanism for the radiolysis of hydrocarbons. It was, however, necessary to assume that excited states of cyclohexane formed directly behave differently from those formed by electron-cation combination. (auth)(Canada)

12346 γ-RADIOLYSIS OF CYCLOHEXANE WITH ELECTRON SCAVENGERS. IV. CO_3 AS AN ELECTRON SCAVENGER. Sagert, N. H. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 46: 336-8(Jan. 1968). (AECL-2983).

The room-temperature, liquid-phase radiolysis of cyclohexane was examined in the presence of CO_2 and of CO_2 with $N_2O \cdot CO_2$ decreased the yields of all major products by scavenging electrons. It was concluded that the CO_2^- anion did not dissociate and that no precursors of cyclohexyl radicals were formed when it was finally neutralized by a hydrocarbon cation. No evidence that CO_2^- acted as an efficient O^- appeared comparable to its rate of reaction with electrons. (auth) (Canada)

12347 DOMAIN SWITCHING IN IRRADIATED FERROELECTRIC KH_2PO_4 OBSERVED BY ELECTRON SPIN RESONANCE. DuVarney, Raymond C.; Kohin, Roger P. (Clark Univ., Worcester, Mass.). Phys. Rev. Lett., 20: 259-62(Feb. 5, 1968).

The first direct observation of domain switching in radiation-damaged ferroelectric KH_2PO_4 using electron spin resonance is

reported. This switching is demonstrated by the observation of a reversal in orientation for the $\cdot OPO_3H^-$ free-radical ions during polarization of the damaged crystal by an electric field. The reversal is accomplished by an intramolecular charge transfer which permits reversal of the damage sites on the microscopic level. (auth)

12348 EFFECT OF GAMMA-NEUTRON RADIATION ON SOME PHYSICOCHEMICAL PROPERTIES OF GLASSES. Byurganovskaya, G. V.; Kisin, B. I.; Orlov, N. F. Opt. Mekh. Prom., No. 3, 34-40(1967). (In Russian).

An investigation was made of the changes in some of the physicochemical properties of ordinary and industrial glasses irradiated in a VVRM reactor with gamma–neutron radiation integral fluxes equal to 10^{17} to 10^{19} thermal neutron/cm^2. The presence of boron or lithium in the glasses strengthened the radiation effect due to the (n,α) reaction. The density of the irradiated glasses increased or decreased (depending on the composition of the glass and the irradiation dose) by approximately 2 to 3%. Specimens of irradiated quartz glass and sodium silicate glass had a higher density than nonirradiated specimens, while in glasses with oxides of heavy metals (barium, lead) the opposite was true. After irradiation, the refraction index generally increased by several units in the fourth decimal place, and the linear expansion coefficient increased a maximum of 2 units in the sixth decimal place. The maximum change in the modulus of elasticity (by absolute values under given irradiation conditions) was ~6%. In most cases, the chemical stability of irradiated glasses did not change noticeably. Although it would seem that the changes in physicochemical properties of glasses irradiated in a reactor are not significant, the quality of various optical devices operating under conditions of irradiation with integral fluxes of 10^{18} to 10^{19} thermal neutron/cm^2 and higher can deteriorate considerably. (ATD)

12349 RADIOLYSIS OF AQUEOUS ALKALINE SOLUTIONS OF CARBON MONOXIDE. Khodzhaev, O. F.; Pikaev, A. K.; Sintsyi, I. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 176: 1120-2(Oct. 11, 1967). (In Russian).

The influence of dose, dose rate, and acid concentration on the radiolysis of carbon monoxide was studied in order to determine the processes resulting in a large yield of formic acid. The specimens were irradiated with 10^{13} to 10^{16} and 10^{21} to 10^{23} eV/ml · sec with a pulse duration of 5×10^{-6} sec. Chromatographic analysis of the products obtained revealed the presence of 0.5% H_2 with the absence of CO_2 and O_2. Curves are given of the concentration of formic acid (produced during γ irradiation of 0.1M solution of KOH saturated with CO) as a function of dose rates 4.4×10^{13} and 4.4×10^{14} eV/ml · sec and of the G(HGOO-) as a function of the concentration of KOH during γ irradiation of CO-saturated solutions with doses of 2.4×10^{17} eV/ml · sec and dose rate of 4×10^{14} eV/ml · sec. (R.V.J.)

12350 ORIGIN OF THE ESR DOUBLETS IN THE NUCLEIC ACID BASE CYTOSINE: A SINGLE-CRYSTAL STUDY AT 8mm WAVELENGTH. Dertinger, Hermann (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 22B: 1266-9(Dec. 1967). (In German).

An ESR-study on an irradiated single crystal of cytosine monohydrate showed a hydroxy radical formed by addition of a hydrogen atom to the $C_{(2)}$= O-double bond that gave rise to a characteristic doublet spectrum. (auth)

12351 THE THERMAL DECOMPOSITION RATE OF POTASSIUM PERMANGANATE EXPOSED TO γ RADIATION. Erofeev, B. V.; Protashchik, V. A. (Inst. of Physico-Organic Chemistry, Belorussian Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 172: 1129-32(Feb. 11, 1967). (In Russian).

Potassium permanganate specimens of varying size were exposed to the γ rays of a ^{60}Co source, determining the effect of irradiation on the subsequent thermal decomposition rate. The chemically pure preparation was ground, separating the fractions with various specific surfaces and exhibiting each fraction to doses of 5, 15, and 25×10^6 R and some of them also to a dose of 1×10^7 R. The thermal decomposition rate was determined at 201.5, 212, 218, and 233°C, indicating the decomposition kinetics by the expression $\log[-\log(1-\alpha)]$ as a function of log t. It was found that for both irradiated and unirradiated specimens, a compensation type mechanism prevails at 212°C. The rate constants were calculated for the temperatures used in the experiments. In view of the delay of time between the exposure and the decomposition experiments, the effect noted was small; the chief effect of radiation on the rate constant was the change of the number of potential nucleation centers, varying from 26 to 2860 for the radiation doses used. (TTT)

12352 PREPARATION AND PROPERTIES OF AN ACENAPHTHYLENE–DIVINYLBENZENE CATION EXCHANGE RESIN. Li, V. P.; Paskov, A. B. (Research Inst. for Plastics Industry, Budapest. Research Inst. for Plastics Industry, Moscow). Acta Chim. Acad. Sci. Hung., 54: 345-60 (1967).

It has been found that the conversion in the copolymerization of acenaphthylene and divinylbenzene depends on the conditions of the reaction (type of initiator, its concentrations, and temperature). A copolymer suitable for the preparation of a sulfocation exchange resin (with an extractable content of 3%) can be prepared at 109°C in 14 hours, using 1% of t-butyl perbenzoate (referred to the weight of the monomer mixture) as initiator. Acenaphthylene–divinylbenzene copolymers of phaneroporous structure have been prepared. A new method has been evolved for the quick measurement of the degree of porosity of the copolymers. It was found by this method that the degree of porosity depends on the ratio of inert solvent and the crosslinking component used. Phaneropores are formed in the copolymer only at a definite ratio of inert solvent to cross-linking component. Copolymers of the required mechanical strength and degree of porosity were obtained at degrees of crosslinking of 24 to 36% and in the presence of 40 to 50% inert solvent. It has been found that porous copolymers can be sulfonated less readily than the common, non-porous copolymers, and the degree of sulfonation decreases with increasing porosity. The resistance to heat and chemical agents, mechanical strength, and the resistance to radiation of the new sulfocation exchange resins have also been examined. The first three parameters of the resin differ only slightly from those of the resin KU-2 (styrene-divinylbenzene), while its radiation resistance has been found three times as high. (auth)

12353 STUDY OF THE NATURE OF ACTIVE CENTRES INITIATING THE LOW TEMPERATURE RADIATION POLYMERIZATION OF ACRYLONITRILE. Kiss, L.; Pravednikov, A. N.; Medvedev, S. S. (Research Inst. for the Plastics Industry, Budapest. Karpov Inst. of Physical Chemistry, Moscow). Acta Chim. Acad. Sci. Hung., 54: 331-44(1967).

The polymerization of acrylonitrile, induced by γ irradiation, has been studied in an electrical field, in the temperature range between −80 and +20°C. It has been concluded from the experimental data that the polymerization is indicated at low temperatures by free anion radicals. There is an equilibrium state between the anion-radical form and the bi-radical form; the actual state of this equilibrium is responsible for the anionic or free radical mechanism of the polymerization. (auth)

12354 THE RADIOLYSIS OF THE COMPLEX OXALATES IN AQUEOUS SOLUTIONS. I. KINETICS AND MECHANISM OF THE RADIOLYSIS OF Co-TRISOXALATO-COMPLEX IN AQUEOUS SOLUTION. Murgulescu, I. G.; Oncescu, T.; Paun, J.; Mihalcea, I. (Univ., Bucharest). Rev. Roum. Chim., 12: 573-81(May 1967).

The decomposition of the cobalt trisoxalato complex by γ- and β-irradiation was followed. The reaction order and the G-values were calculated. From the influence of some scavengers and dose rate on the rate constant, a mechanism for the complex decomposition is presented. An attempt to estimate the rate constant for the reaction: $\cdot[Co(C_2O_4)_3]^{3-} + H \rightarrow [Co(C_2O_4)_2]^{2-} + C_2O_4^{-} + H^+$, is made. (auth)

12355 PREPARATION OF ^{32}P BY SOLVENT EXTRACTION METHOD. Nakamura, Haruto (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 10: 2-6(Jan. 1968). (In Japanese).

^{32}P is almost quantitatively separated from the bulk of the sulfur target by shaking a carbon disulfide or bromoform solution of neutron-irradiated sulfur with dilute ammonia. Extraction with an acid solution results in lower recovery. While bromoform is not a very good solvent for sulfur at room temperature the solubility increases with temperature. It has the advantage over carbon disulfide in that it is not inflammable. From an aqueous extract, ^{32}P can be purified by either anion exchange, extraction, or lantanium hydroxide coprecipitation. For processing of ^{32}P, the anion-exchange method is the most convenient; ^{32}P was obtained with a recovery of 85% by bromoform–ammonia extraction at 80°C followed by anion-exchange purification. (auth)

12356 NATURAL RADIOACTIVITY AND SOLUBILITY OF SILICON DUSTS. Lastkov, O. A. (Central Scientific-Research Lab., Don, USSR). Gig. Sanit., No. 10, 40-4(Oct. 1967). (In Russian).

It was found that certain changes in the physicochemical properties of quartz dust could be attained by irradiation. The solubility of a series of silicon dusts increased as a result of their treatment with ionizing radiation in doses from 5 to 450 RAD. However, the irradiation effect was of a temporary nature. The sorptive properties of irradiated dust tended to change. The roentgenograms revealed certain intensification of the diffraction that later disappeared in one to four months. The differences in the solubility

of natural quartz dusts, that were practically identical in their chemical composition, could be traced to the presence of natural radioactive admixtures. (auth)

12357 FORMATION OF $(e^-)_2$ CENTERS IN RADIOLYSIS OF AQUEOUS ALKALI "VITREOUS" SOLUTIONS. Khodzhaev, O. F.; Ershov, B. G.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim., No. 8, 1882(Aug. 1967). (In Russian).

Low-temperature radiolysis of vitreous alkaline solutions containing formates, carbonates, or CH_3OH resulted in restoration of color $e^-_{capt.}$ during heating at 130°K. This effect was more pronounced in the case of 10M NaOH + 1M HCOONa in which 40% of initial color $e^-_{capt.}$ was restored. Irradiation of photoannealed specimens by long light waves over 700 mμ also partially restored the color $e^-_{capt.}$ which indicates the light absorption $(e^-_{capt.})_2$ by local centers. The effect described was not observed in neutral, aqueous or alcohol glasses. (R.V.J.)

12358 PERTURBED ORBITAL ENERGIES IN THE RADIOLYSIS OF SATURATED HYDROCARBONS. So, Moon-tak; Huang, Suei-rong (Long Island Univ., Brooklyn). J. Chem. Phys., 47: 4896-4901(Dec. 15, 1967).

In the combination of two saturated hydrocarbon radicals forming a new bond, a perturbed orbital energy will arise. This energy is equivalent to the energy necessary to decompose the product molecule into the two original radicals. By comparing perturbed orbital energies, it is possible to predict the decomposition products of irradiated molecules. The secular equations derived are solved using the LCBO molecular–orbital approximations. Theoretical predictions of radiolytic decomposition products, based on the calculated perturbed orbital energies, are then compared with experimental G values. The agreement between theory and experiment is satisfactory. (auth)

12359 γ RADIOLYSIS OF LIQUIDS AT HIGH PRESSURES. V. REACTION OF THE HYDRATED ELECTRON WITH WATER. Hentz, Robert R.; Farhataziz; Milner, David J. (Univ. of Notre Dame, Ind.). J. Chem. Phys., 47: 5381-4(Dec. 15, 1967). (COO-38-554).

The γ radiolysis of deaerated aqueous solutions containing 10^{-2} or 10^{-3}M glucose and 10^{-5} to 10^{-4}M of H_2O_2 or NO_3^- was studied at ~20°C in the applied pressure range 0 to 6.34 kbar. The behavior of H_2O_2 and NO_3^- solutions was essentially indistinguishable. In both the H_2O_2 and NO_3^- solutions, $G(H_2)$ increased with increasing pressure; at 6.34 kbar, $G(H_2)$ decreased with increasing H_2O_2 or NO_3^- concentrations. However, the pressure dependence of $G(H_2)$ was not affected by a change in glucose concentration from 10^{-2} to 10^{-3}M or by a change in atmospheric pressure pH from ~7 to 9. The results are interpreted in terms of an effect of pressure on the competition between reactions: $e^-_{aq} + NO_3^-$(or H_2O_2) → no H or H_2 (4) and $e^-_{aq} + H_2O \rightarrow H + OH^-$ (5), followed by $H + RH \rightarrow H_2 + R$. Such an interpretation gives a difference in activation volumes of the reactions as $\Delta V_4^{\ddagger} - \Delta V_5^{\ddagger} \approx 15.7$ ml mole^{-1} and a specific rate $k_4^0 \approx 25 M^{-1} \cdot sec^{-1}$ at atmospheric pressure. Assumption that reaction (4) is diffusion controlled permits estimation of $\Delta V_4^{\ddagger} \approx 1.6$ ml mole^{-1}, from the pressure dependence of water viscosity. Thus $\Delta V_5^{\ddagger} \approx -14.1$ ml mole^{-1}. The latter value is used to estimate an absolute value of $\overline{V}_0(e^-_{aq})$ in the range –1.7 to either 2.7 or 9.6 ml mole^{-1} (dependent on the model assumed for the activated complex); such a range for $\overline{V}_0(e^-_{aq})$ is in satisfactory agreement with a previous estimate. (auth)

12360 PARAMAGNETIC RELAXATION OF TRAPPED HYDROGEN ATOMS IN IRRADIATED FROZEN AQUEOUS SOLUTIONS. Zimbrick, John; Kevan, Larry (Univ. of Kansas, Lawrence). J. Chem. Phys., 47: 5000-8(Dec. 15, 1967).

The paramagnetic relaxation characteristics of trapped hydrogen atoms in γ-irradiated acidic and oxyanion ices were studied by power-saturation techniques. Relaxation times were measured as a function of radiation dose, deuteration, phase, and solute. The EPR linewidth of the trapped hydrogen atom was measured under various conditions. The EPR lineshape and power-saturation response indicate that the linewidth is due to contributions from both homogeneous and inhomogeneous interactions. The changes in relaxation time with radiation dose indicate that hydrogen atoms are trapped with a uniform distribution near oxyanions in the ice and are not trapped within radiation-produced spurs. The presence of phase effects on relaxation times supports an interstitial-defect model for the hydrogen-atom trapping site and suggests that the trap potential energy well is shallower in the polycrystalline phase than in the glassy phase. In polycrystalline ices the coupling between trapped hydrogen atoms and lattice phonons is modified by the type of oxyanion. (auth)

12361 CONDENSED-PHASE PHOTOLYSIS AND RADIOLYSIS OF 2-METHYLBUTANE. Scala, A. A; Ausloos, P. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 47: 5129-39(Dec. 15, 1967).

The condensed-phase photolysis of $i\text{-}C_5H_{12}$–$i\text{-}C_5D_{12}$ mixtures, and $CH_3CD(CH_3)CH_2CH_3$ was investigated at photon energies above and below the ionization energy of 2-methylbutane (10.32 eV), that is, at 1470 Å (8.4 eV), 1236 Å (10.0 eV), and 1048 to 1067 Å (11.6 to 11.8 eV). The electronically excited 2-methylbutane molecule undergoes essentially the same primary decomposition processes in the condensed phase as in the gas phase. However, in contrast with the gas phase, the internally excited fragments formed in these primary processes are entirely deactivated. It is demonstrated that $C_5H_{12}^+$ ions are produced at 1048 to 1067 Å and to a lesser extent at 1236 Å. A fraction of these ions transfer an H_2 molecule to $c\text{-}C_5D_8$ to form $CD_2HCD_2CD_2H$ as a product. In the krypton- and argon-sensitized radiolysis at 77 and 20°K, respectively, energy transfer from the rare gas matrix to 2-methylbutane occurs with high efficiency and all products can be accounted for by decomposition of neutral, excited 2-methylbutane, formed by excitation transfer and/or neutralization of ions formed in charge-transfer reactions with rare gas ions. In the radiolysis of pure 2-methylbutane at 77°K, ethane and propane are almost entirely formed through molecular elimination and geminate radical disproportionation processes. Addition of an electron scavenger such as CCl_4 lowers the yields of these products, as well as those of the corresponding olefins (e.g., C_3H_6 and C_2H_4). A change in the neutralization mechanism of the parent ion ($C_5H_{12}^+$) can account for the latter observation. Apparently, fragmentation of the parent ion is unimportant in the condensed phase. Butane ($G \sim 0.1$) is the only product that can tentatively be related to reaction of fragment ions ($C_4H_9^+$, $C_4H_8^+$). The modes of formation of products, such as the pentenes and the hydrogen in the radiolysis of pure C_5H_{12} remain unexplained. (auth)

12362 ISOTHERMAL ANNEALING OF REACTOR IRRADIATED CRYSTALLINE CHEMICAL COMPOUNDS. Dimotakis, Paul N. (Democritus Nuclear Research Center, Athens). J. Inorg. Nucl. Chem., 30: 29-34(Jan. 1968).

The isothermal annealing of crystalline potassium chromate and trisethylenediamine cobalt(III) nitrate irradiated in a nuclear reactor was extensively examined. A total of 1200 analyses were carried out to construct, in a more precise form, isothermal curves. The samples had received various doses of fast neutrons and gamma rays and were heated at various temperatures. The isothermal curves show many maxima and minima and the accuracy of the measurements exclude any possibility that these effects reflect a random fluctuation of the data. There was also some indication that in a family of isothermal curves maxima and minima move to shorter times on increasing the temperature. (auth) (UK)

12363 ANNEALING PHENOMENA IN REACTOR IRRADIATED POTASSIUM CHROMATE PELLETS IN CONTACT WITH BORIC ACID PELLETS. Dimotakis, Paul N.; Stamouli, Maria I. (Democritus Nuclear Research Center, Athens). J. Inorg. Nucl. Chem., 30: 23-7(Jan. 1968).

The annealing of recoil ^{51}Cr fragments in reactor irradiated potassium chromate pellets in contact with boric acid pellets was examined. The retention increased as the width of the potassium chromate pellet increased up to a certain maximum which corresponded to 800 μ distance from the boric acid surface. The effect was due to the release of α-particles from the $^{10}B(n,\alpha)^7Li$ reaction in the boric acid pellet. Since the range of α-particles of the relevant energy was only a few μ, it was postulated that a secondary mechanism of energy transportation into the potassium chromate lattice was responsible for the annealing. Such a mechanism would be an exciton transfer. (auth) (UK)

12364 EFFECT OF PULSED γ-NEUTRON IRRADIATION ON PERMITTIVITY OF METHYL METHACRYLATE POLYMERS. Zubov, V. V.; Khokhryakov, V. F.; Tuturov, Yu. F. Vysokomol. Soedin., Ser. A, 9: 2746-50(Dec. 1967). (In Russian).

Methods for measuring permittivity and the tangent of losses of dielectrics in the course of their irradiation with pulsed γ-neutrons are described. Data on the effect of pulsed γ-neutron irradiation on the permittivity of methyl methacrylate polymers are given. (auth)

12365 YIELD OF LUMINESCENCE FROM X-IRRADIATED BIOCHEMICALS. Nelson, D. R. (Oak Ridge National Lab., Tenn.); Carter, J. G.; Birkhoff, R. D.; Hamm, R. N.; Augenstein, L. G. Contract AT(11-1)-1155. Radiat. Res., 32: 723-43(1967).

The absorption of energy by complex biological molecules when they are irradiated by ionizing radiations may lead to various electronic rearrangements before the excitation energy is finally dissipated. To further understand the nature of the excited states produced in these molecules by ionizing radiations, estimates were made of the fraction of energy absorbed from x rays by pow-

dered samples of the aromatic amino acids and the enzymes trypsin, lysozyme, and ribonuclease, which is finally re-emitted as luminescence. Values of average energy absorbed per quantum of immediate luminescence emitted are given. (C.H.)

12366 RESPONSE OF ORDINARY GLASS SLIDE TO GAMMA RADIATION. Herrera, J. R.; Cruz, A. Z.; Valencia, I. G.; Navarro, Q. O. (Philippine Atomic Research Center, Diliman). Philippines Nucl. J., 1: 93-9(Jan. 1967).

The response of microscopic glass slides to gamma radiation and its possible use as a megaroentgen dosimeter were studied. Two types of glass slides, GLS-1—chance microscope slide and GLS-2—noncorrosive microscope slides, were exposed to ^{60}Co gamma radiation. Glass slides exposed to gamma dose ranging from 10^4 to 10^6 R exhibited an absorption band in the visible region with a broad peak at 410 mu. The response of GLS-1 to dose was linear up to 7×10^5 R while that of GLS-2 was linear up to 5×10^5 R. Fading of absorption bands within 24 hours at room temperature was observed. Heat treatment for one hour at 98°C effected a 48% fading after which the color became stable. To determine the effect of sunlight on color stability, aluminum foil-covered glass slides were exposed to gamma radiation at doses of from 10^4 to 10^6 R. The response to dose was also linear. However, the absorption band was 14.5% lower than that of the uncovered glass slides. Fading was also observed, and heat treatment gave the same effects as those observed in the uncovered glass slides. (auth)

12367 γ RADIOLYSIS OF LIQUIDS AT HIGH PRESSURES. IV. PRIMARY YIELDS IN NEUTRAL AQUEOUS SOLUTIONS. Hentz, Robert R.; Farhataziz; Milner, David J. (Univ. of Notre Dame, Ind.). J. Chem. Phys., 47: 4865-7(Dec. 1, 1967).

For various neutral solutions, radiolytic yields obtained at 6.34 kbar were compared with the corresponding yields obtained at atmospheric pressure. The following aqueous solutions were studied: N_2O–glucose, KBr, tetranitromethane, and tetranitromethane–sodium formate. Results indicated that primary yields of e^-_{aq}, H, OH, and H_2 are unaltered at 6.34 kbar. (M.C.G.)

12368 PREPARATION OF ANHYDROUS $H^{18}F$. Nozaki, T.; Tanaka, Y.; Shimamura, A.; Karasawa, T. (Inst. of Physical and Chemical Research, Saitama, Japan). Int. J. Appl. Radiat. Isotop., 19: 27-32(Jan. 1968).

Two methods of preparing anhydrous $H^{18}F$ are described. An oxygen gas steam is bombarded with an α or ^3He beam to yield ^{18}F; this ^{18}F remains within the bombardment vessel, being adsorbed almost quantitatively on its inside wall. By occasionally adding a small quantity of gaseous HF into the oxygen stream, the ^{18}F is eluted by virtue of the rapid isotopic exchange; the $H^{18}F$ is caught in a cold trap. Neutron-irradiated Li_2CO_3 is dissolved in sulphuric acid containing a trace of H_2SiF_6; the ^{18}F is steam-distilled and then adsorbed by anion exchange resin. The resin is then dried, and the ^{18}F is eluted with gaseous HF. (auth) (UK)

12369 UNSTABLE INTERMEDIATES. PART XLVII. ELECTRON SPIN RESONANCE STUDY OF THE RADICAL $(CN)_2^-$ IN IRRADIATED ALKALI METAL CYANIDES AND POTASSIUM CHLORIDE CRYSTALS. Root, K. D. J.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A, No. 1, 21-4(1968).

Gamma-irradiation of sodium and potassium cyanide yields the radical $(CN)_2^-$, the cyanogen negative ion, which is analogous to the V_K-centers formed by irradiation of alkali halides. The electron spin resonance spectrum of the radical trapped in a single crystal of potassium chloride is reported and used to derive information about its shape and electronic structure. (auth) (UK)

12370 CHEMISORPTION ON SOME ALKALINE EARTH OXIDES. PART 2. INTRINSIC BULK DEFECTS AND ADSORPTION OF OXYGEN ON MgO, CaO, AND SrO. Nelson, R. L.; Tench, A. J. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Faraday Soc., 63: 3039-59(Dec. 1967).

A slow adsorption of oxygen on MgO and CaO powders is enhanced after γ- or neutron-irradiation; ESR studies indicated that F centers contribute to the adsorption on neutron-irradiated material, with the F-center decay and adsorption processes both obeying Elovich kinetics. Annealing of irradiated MgO showed that the F centers affected by oxygen are also those that are thermally least stable and presumably correspond to those defects closest to the oxide surface. Adsorption of oxygen leads to the annihilation of the F center defect rather than loss of the trapped electron, and the potential barrier thus produced controls the rate of the subsequent reaction. Oxygen is adsorbed on unirradiated, γ-irradiated and neutron-irradiated SrO powders with diffusion-controlled kinetics. F centers play only a minor role in neutron-irradiated SrO, but allow the estimation of diffusion coefficients of adsorbed oxygen species in the oxide. A fast initial adsorption of oxygen involves only the surface regions. (auth) (UK)

12371 STRUCTURAL CHANGES OF BARIUM METHACRYLATE DIHYDRATE UNDER X-RADIATION. Isaacs, N. W.; Kennard, C. H. L.; O'Donnell, J. H. (Univ. of Queensland, St. Lucia, Australia). Nature (London), 216: 1104(Dec. 16, 1967).

Studies are described on the structural decomposition of barium methacrylate dehydrate continuously subjected in powder form to x-irradiation at 25°C. The kinetics were followed by measuring the decrease in intensity of three powder diffraction peaks (100, 200, 002). Irradiation was carried out at three different dose rates (69,500; 205,000; and 556,000 R/hr), and curves are given showing the dose rate dependence of conversion from crystalline to amorphous material. There was an increase of decomposition rate with increasing intensity of irradiation. As the large absorption coefficient of the material results in a half-thickness of 20μ for the x-ray beam, the observed effect was of a surface nature. It was concluded that the observed structural decomposition was caused by polymer formation. Results are compared with those induced by γ-radiation. (UK)

12372 COMPARATIVE STRENGTHS OF POLYTETRAFLUOROETHYLENE AND POLYCHLOROTRIFLUOROETHYLENE UNDER NUCLEAR RADIATION. Harrison, V. A. W. (Radio and Space Research Station, Slough, Eng.). Radio Electron. Eng., 35: 54(Jan. 1968).

Samples of PTFE and PCTFE were outgassed at 1×10^{-6} torr and 100°C for 24 hr prior to sealing in glass ampoules; the outgassing is important, since rapid degradation occurs on irradiation in the presence of oxygen. The samples were then irradiated, using a 4-MeV electron beam, to doses of 1 to 40 MR, followed by storage at 35°C for 24 hr to avoid effects due to variations in coefficient of expansion that occur at room temperature. Tensile strength and elongation determinations were made at the same temperature. Although PCTFE has initially about twice the strength of PTFE, it degrades rapidly with dose in excess of about 10 MR, and appears weaker than PTFE at higher radiation levels. Even small doses produced substantial changes in elongation for both materials. (UK)

12373 SUSPENSION GRAFTING OF STYRENE ONTO PRE-IRRADIATED RAYON. Gotoda, Masao (Japan Atomic Energy Research Inst., Tokyo); Kubota, Hiroshi. Kogyo Kagaku Zasshi, 70: 1606-7(Sept. 1967). (In Japanese).

Suspension grafting of styrene onto pre-irradiated rayon was investigated and the results compared with those obtained in the emulsion grafting process. The effect of agitation in the suspension on the grafting rate was also studied. The grafting rate increased under continuous stirring; the grafting rate observed in the suspension grafting under stirring was nearly the same as that observed in the emulsion grafting; and no homopolymer was found in the suspension phase, in contrast to the emulsion grafting. (auth) (NSA of Japan)

12374 EFFECTS OF EMULSIFIERS AND OXYGEN ON THE EMULSION GRAFTING OF STYRENE ONTO PRE-IRRADIATED RAYON. Gotoda, Masao (Japan Atomic Energy Research Inst., Tokyo); Veno, Takeo. Kogyo Kagaku Zasshi, 70: 1578-82 (Sept. 1967). (In Japanese).

Effects of emulsifiers and oxygen on the emulsion grafting of styrene onto pre-irradiated rayon, which was irradiated by electron beams in the presence of air, were investigated. The main results obtained were: the emulsion grafting process, as compared with the solution grafting process in methanol, is apparently less sensitive to an inhibiting action of oxygen for graft-polymerization; anionic or nonionic detergents are generally adequate for this process but cationic ones are not suitable, (especially, in the cases of anionic emulsifiers, the inhibiting action of oxygen on the grafting rate was observed to be very little); and the increase in emulsifier concentration gives generally a gradual decrease of the grafting rate and the grafting efficiency. (auth) (NSA of Japan)

12375 SEPARATION OF PLATINUM AND GOLD ON CATION EXCHANGE RESIN IN CONCENTRATED HBr SOLUTION. PREPARATION OF CARRIER-FREE ^{199}Au. Maleszewska, Hanna; Dybczynski, Rajmund (Inst. of Nuclear Research, Warsaw). Nukleonika, 12: 1181-3(1967).

It was found that in the system Dowex 50W × 8 $[H^+]$–6M HBr the distribution coefficient of gold is of the order of 10^2 while that of platinum is close to 0. It was apparent from both elution curves and γ spectra that complete resolution was achieved. This makes possible the preparation of radiochemically pure platinum and carrier-free ^{199}Au. (M.C.G.)

12376 GAMMA-RADIOLYSIS OF GASEOUS SYSTEM ETHYLENE–OXYGEN–AMMONIA. Bierzynski, Andrzej; Gawlowski, Janusz; Bialski, Aleksander; Taube, Mieczyslaw (Univ., Warsaw). Nukleonika, 12: 1175-80(1967). (In Polish).

The gaseous system: $C_2H_4 + O_2 + NH_3$ was irradiated in the γ field of a nonoperating reactor. The products of radiolysis were identified and the yield of some of them was determined at dose rates of 50 to 100 Mrads. Among the products of hydrolysis glycine and α- and β-alanine were found. The amount of these compounds indicated that the yield of their precursors exceeded 0.1 molecules/100 eV. (auth)

12377 SIMULTANEOUS RADIOLYTIC AND PYROLYTIC DECOMPOSITION OF DECAHYDRONAPHTHALENE, TETRAHYDRONAPHTHALENE, AND THEIR MIXTURES WITH NAPHTHALENE. Stachowicz, Waclaw; Kecke, Zbigniew; Minc, Stefan (Inst. of Nuclear Research, Warsaw). Nukleonika, 12: 1135-44 (1967).

Radiolytic and pyrolytic decomposition of decahydronaphthalene, tetrahydronaphthalene, and of two- and three-component mixtures of these hydrocarbons with naphthalene were investigated separately and simultaneously as well. The influence of dose, temperature, and composition of irradiated and heated solutions on radiolytic and pyrolytic yields of the products (hydrogen and C_1–C_5 hydrocarbons) were determined. On the basis of these data activation energies of thermal decomposition of decahydronaphthalene and tetrahydronaphthalene in the liquid state were calculated and radiolytic and pyrolytic stabilities of the systems under the conditions applied were evaluated. Explanation of observed effects is proposed. (auth)

12378 RADIATION-INDUCED IONIC POLYMERIZATION OF STYRENE. Burns, F. W.; O'Connor, R. M.; Pepper, D. C. (Trinity Coll., Dublin). J. Polym. Sci., Part B, 5: 1059-61 (Dec. 1967).

The gamma irradiation of dried styrene was performed at ambient temperature (~20°C) and at varying dose rates. Linear contraction-time relations were found with all samples and dose rates. Rates characteristic of ionic reactions were obtained even with relatively crude drying and handling procedures. These rates and radiation yields were not reduced by concentrations of carbon dioxide that should have been sufficient to suppress anionic propagation (though very high concentrations <500 nmolar did cause reduction). An appreciable proportion of low-molecular-weight material was produced. It was concluded that any propagation by anionic species was very small. (J.G.B.)

12379 γ-RAY-INDUCED POLYMERIZATION OF SOME VINYL-SUBSTITUTED SILANES. Hayakawa, Kiyoshi; Kawase, Kaoru; Yamakita, Hiromi; Inagaki, Shinji (Government Industrial Research Inst., Nagoya, Japan). J. Polym. Sci., Part B, 5: 1077-81 (Dec. 1967).

The gamma irradiation of several monovinylsilanes in the liquid state produced viscous polymeric substances. The G-value of conversion was much higher for ethoxyvinylsilane than for the other monomers. Ethoxyvinylsilane polymer was found to be more stable in water than the methoxyvinylsilane, dichloromethylvinylsilane, or trichlorovinylsilane polymers. Infrared spectra of the above-mentioned polymers were much the same as those of their monomers except for a decrease of the C=C absorption band. New bands were observed in spectra of diethylvinylsilane and triethylvinylsilane polymers. (J.G.B.)

12380 ETCHING OF IRRADIATED POLYETHYLENE WITH FUMING NITRIC ACID. Salovey, R.; Hellman, M. Y.; Matreyek, W.; Winslow, F. H. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Polym. Sci., Part B, 5: 1131-4(Dec. 1967).

Preirradiation produced no detectable change in the molecular weight of solution- or melt-crystallized polyethylene etched by fuming nitric acid. Results were consistent with crosslinking in areas which are selectively eroded by nitric acid. (auth)

12381 INDUSTRIAL APPLICATIONS OF IRRADIATION. Rondenay, F. Energ. Nucl. (Paris), 9: 429-33(Nov. 1967). (In French).

Irradiation is a process that is beginning to be used by industry. The radiosterilization of medical instruments to be used only once is developing very rapidly. The chemical industry also uses it and now delivers products to consumers in which radiation was used during their manufacture. Some examples are given including crosslinking of polyethylene and impregnation of wood. (auth)

12382 γ-RADIOLYSIS OF AQUEOUS THYMINE SOLUTIONS. DETERMINATION OF RELATIVE REACTION RATES OF OH RADICALS. Scholes, G.; Willson, R. L. (Univ. of Newcastle upon Tyne, Eng.). Trans. Faraday Soc., 63: 2983-93(Dec. 1967).

The loss of absorption of the chromophoric group of thymine on irradiation in aqueous solution with γ rays was studied under a variety of conditions. The effects of thymine and oxygen concentrations, of pH, and of the presence of N_2O were investigated. In solutions containing oxygen the loss of absorption is the result of initial OH radical attack on the pyrimidine molecule; radioinduced electron attachment to thymine does not lead to destruction of the chromophoric group if oxygen is present in the system. Aerated thymine solutions (8×10^{-5} to 2×10^{-4} M) were used to determine, spectrophotometrically, the relative reactivities of solutes towards OH radicals; because of an unusual pH effect observed in neutral solutions, the competition experiments were carried out below pH 6. The reactivities of a number of organic solutes were obtained. Similar rate constant ratios were obtained in solutions containing N_2O, indicating that N_2O^- was not an oxidizing species under the conditions of the experiments. (auth) (UK)

12383 IRRADIATED POLYETHYLENE. III. EVIDENCE FOR AN IONIC MECHANISM IN ALLYL-FREE RADICAL FORMATION. Auerbach, I. (Sandia Corp., Albuquerque, N. Mex.). Polymer, 9: 1-6(Jan. 1968).

Radiation interacting with polyethylene forms alkyl ions that in turn provide allyl-free radicals. Charge and radical migration mechanisms are considered for the processes whereby reactivity is transferred from the initial alkyl ion to the allyl radical site. The following considerations provide evidence for a charge migration mechanism: (1) An ionic mechanism that would involve a charge migration process would be expected to be intramolecular in character, whereas a radical mechanism would not be restricted to intramolecular migration. Statistical models are considered for charge and radical migration, and compared with experimental results. The comparative results favor a charge migration process. (2) The G values for vinyl decay in polyethylene and for the polymerization of lower molecular weight 1-olefins, which are known to undergo ionic rather than radical reactions, are sufficiently close to suggest that the same mechanisms are operative in both materials. (3) Radioinduced ionic polymerizations show no dose-rate effect, whereas radioinduced free radical polymerizations are proportional to the square root of the radiation intensity. As allyl radical formation showed no dose-rate effect, additional evidence is provided for an ionic process. (auth) (UK)

12384 CHEMISTRY OF ^{82}sBr RECOILS IN NEUTRON-IRRADIATED CRYSTALLINE ALKALI METAL BROMATES. Boyd, G. E.; Larson, Q. V. (Oak Ridge National Lab., Tenn.). J. Amer. Chem. Soc., 90: 254-60(Jan. 17, 1968).

The analysis of neutron-irradiated crystalline alkali metal bromates by anion-exchange chromatography showed that the ^{82}sBr recoils produced in the crystals were distributed in varying amounts among four oxidation states of the element: BrO_3^-, BrO_2^-, BrO^-, and Br^-. The species BrO^- and BrO_2^- were labile and disappeared on heating the irradiated crystals. A nearly complete recombination of all radiobromine to bromate was effected by heating neutron-bombarded $LiBrO_3$, $KBrO_3$, and $CsBrO_3$ for 1 hr at temperatures approaching their melting points. Irradiation with ^{60}Co γ rays also induced the recombination to bromate, and significant differences in annealing rates depending on the cation in the salt were observed. The transfer to bromate by heating of radiobromide added to pure alkali metal bromate crystals was demonstrated. Neutron irradiations of mixed crystals of $NaBrO_3$ + $NaClO_3$ showed that the fraction of ^{82}sBr combined as bromate doubled on going from pure $NaBrO_3$ crystals to a 1% by weight solid solution of $NaBrO_3$–$NaClO_3$. A model based on the production of radiobromine recoils in small, isolated regions of localized disorder in the crystal was employed in a discussion of the kinetics of their thermal and radiation annealing to form radiobromate. (auth)

12385 RADIATION POLYMERIZATION OF CRYSTALLINE TRITHIANE. Mammi, M. (CNR, Padua. Univ., Padua); Valle, G.; Carazzolo, G. Nuovo Cim., (10), 53B: 73-86(Jan. 11, 1968).

It was shown that by radioinduced solid-state polymerization of crystalline trithiane, twinned crystals of hexagonal polythiomethylene are formed and the process is directed by the trithiane crystal packing. Growing of polymeric chains occurs mainly along two equivalent directions parallel to the diagonals of the trithiane crystallographic ab plane, and, to a less extent, along the c axis of the trithiane unit cell. (auth)

12386 AFTER-EFFECT OF γ-IRRADIATION OF CELLULOSE. Christensen, Per Koch (Norges Tekniske Hoegskole, Trondheim, Norway); Tolbert, Bert M. Norsk Skogind., 19: No. 1, 13-17(1965). (COO-690-16).

Cellulose was irradiated in vacuo with γ rays from a ^{137}Cs source. The reduction of degree of polymerization (DP) was followed viscosimetrically in Cu–ethylenediamine solutions. To avoid breakdown of alkali–unstable groups under these conditions, carbonyl groups were reduced with $NaBH_4$. The difference in viscosity of reduced and nonreduced cellulose was followed when irradiated samples were stored. It is shown that the relation between the production of chain breaks and CO groups during aging

changes with time. The amount of CO groups was also estimated through H_3PO_4-fluidity measurements with results in agreement with the Cu–ethylenediamine viscosity measurements on $NaBH_4$-reduced and nonreduced samples. (auth)

12387 REACTION OF THE HYDRATED ELECTRON. Fujita, Shin-ichi; Horii, Hideo; Taniguchi, Setsuo; Kawabata, Keisuke; Okabe, Shigeru. Annu. Rep. Radiat. Center Osaka Prefect., 7: 72-5(1966).

The pulse-radiolysis technique was used to follow the decay rate of hydrated electrons in alkaline aqueous ethanol solutions at various temperatures. The activation energies obtained for the reaction of hydrated electrons with water were 3.8 kcal/mole in H_2O and 4.7 kcal/mole in D_2O. The activation energy for the bimolecular reaction ($e^-_{aq} + e^-_{aq}$) was 2 kcal/mole and was small compared with that expected for the diffusion-controlled reaction. (auth)

12388 STUDIES ON EXTRACTION OF ELEMENTS BY GAMMA IRRADIATION. II. Asai, Takuo; Azuma, Toshio. Annu. Rep. Radiat. Center Osaka Prefect., 7: 98(1966).

It was previously reported that some elements can be extracted by gamma-irradiation from insoluble materials into water. This time, the same procedure was performed on activated material. (auth)

12389 VARIATION OF TOTAL BINDING ENERGY IN IRRADIATED MOLECULAR SYSTEMS. Naudet, Gilbert; Passe, Suzanne. Compt. Rend., Ser. C, 265: 1300-2(Dec. 6, 1967). (In French).

By means of experimental results, selected from the literature, the variation in binding energy in a molecular system under irradiation was studied. This variation in binding energy was compared with the total binding energy of the system and with the energy absorbed in the medium in the course of the irradiation. (tr-auth)

12390 CATALYTIC DEUTERIUM EXCHANGE REACTIONS WITH ORGANICS. XXXVI. THE LABELLING OF (–)-INOSITOL ON SELF-ACTIVATED PLATINUM OXIDE WITH AND WITHOUT RADIATION. Angyal, S. J.; Fernandez, C. M.; Garnett, J. L. (Univ. of New South Wales, Kensington). Aust. J. Chem., 20: 2647-53(Dec. 1967).

Exchange of (–)-inositol with curie levels of tritiated water on self-activated platinum oxide led to incorporation of tritium of which 92.5% was found at C1 and C6, 3.7% at C2 and C5, and 3.8% at C3 and C4. Isotope scavenging indicates that inversion occurred only at C1 yielding labeled myoinositol. Exchange was accelerated in the presence of uv light without extensive degradation. A comparison was made between the Wilzbach gas irradiation technique and the catalytic method for labelling (–)-inositol. Possible mechanisms for tritium incorporation in (–)-inositol are discussed for the various experimental conditions used. (auth)

12391 RADIATION EFFECTS ON CATALYSIS. Gasper, Kenneth Albert. Madison, Wis., Univ. of Wisconsin, 1966. 202p.

Thesis.

The effects of Ar ion bombardment on the catalytic activity and contact potential of Ge were studied. An all-metal ultrahigh vacuum system using a getter-ion pump was constructed. In this system a 1⅛" diameter Ge crystal wafer with (100) orientation was ion bombarded with 300 eV Ar ions. The bombardment cleaned and damaged the Ge surface; annealing at 500°C removed the damage. The change in contact potential of the Ge with ion bombardment was measured with respect to a W single crystal of (111) orientation using the Kelvin vibrating capacitor method for the contact potential difference measurement. Ion bombardment produced an increase in the Ge work function of 0.18 ± .04 eV for one crystal and −0.14 to +0.30 eV for a second crystal. The first crystal was 25 to 45 ohm cm resistivity and the second 0.3 to 0.8 ohm cm with unknown impurity. Catalytic activity was determined by the per cent conversion for the hydrogenation of ethylene reaction. Measurements were made with a mass spectrometer. Bombarded (damaged) catalyst crystals produced 9% conversion, annealed (undamaged) crystals produced 12% conversion, while background (no catalyst in chamber) was 8%. Thus bombardment caused a decrease in catalyst activity, perhaps due to a decrease in the ease of ethylene adsorption. Measurements were made over the pressure range 9×10^{-6} mm Hg to 2×10^{-4} mm. Higher conversions resulted at lower pressures; results agreed with a reaction rate dependence on $P^0_{H_2} \cdot P^{-\frac{1}{2}}_{C_2H_4}$ or possibly $P^{-\frac{1}{4}}_{H_2} P^0_{C_2H_4}$. (Disser. Abstr.)

12392 REACTIONS OF HOT TRITIUM ATOMS WITH METHANE AND HYDROGEN. Seewald, David Allan. New Haven, Yale Univ., 1967. 121p.

Thesis.

Reactions of hot tritium with H_2, D_2, and HD were studied. Tritium preferentially reacted with H_2 when reacting with an equimolar D_2-H_2 mixture, while reaction with deuterium was favored in the reaction of tritium with HD. The data for all reactions studied were analyzed using the kinetic theory of hot reaction. Reactivity integrals I, and energy loss parameters α were evaluated. Ratios of the values obtained for the T + D_2 and T + CH_4 reactions are in agreement with the corresponding ratios as independently derived from studies of the T + (CH_4-D_2) system. This provides a check of the experimental method and the validity of the assumptions in the kinetic theory. Ratios of α values obtained are compared with theoretical values predicted by both soft sphere and hard sphere elastic collision models. The reactivity integrals for H_2 are compared with corresponding quantities for T + H_2 and T + D_2 as calculated by Karplus, Porter, and Sharma using a quasi-classical Monte Carlo method to compute cross sections as a function of energy. Agreement on absolute values was remarkably good for a first comparison of experiment and mechanistic theory in hot atom chemistry. However, theoretical and experimental isotope effects show what appears to be a significant difference. (Disser. Abstr.)

12393 INFLUENCE OF OXYGEN ON THE REACTIONS OF RECOIL CARBON ATOMS WITH SATURATED HYDROCARBONS AND GENERALIZED DESCRIPTIONS OF PRODUCT YIELDS FROM THE REACTIONS OF ENERGETIC CARBON ATOMS WITH SATURATED HYDROCARBONS IN OXYGEN-SCAVENGED SYSTEMS. Lieberman, Peter. New York, City Univ. of New York, 1967. 154p.

Thesis.

The reactions of carbon atoms of high translational energy ("hot" carbon atoms) with saturated hydrocarbons in the presence of O_2 were investigated. The reaction system is generated by bombarding the gaseous hydrocarbon-oxygen substrate mixture with nuclear particles, inducing the ^{12}C-(n,2n)^{11}C reaction or the ^{12}C(p,pn)^{11}C reaction in an infinitesimal fraction of the carbon atoms. The converted atoms recoil at high energy, breaking their chemical bonds. The high kinetic energy of the atoms is degraded in collisions with the substrate molecules until energies are low enough for reactions to give stable chemical species. The products containing ^{11}C are separated and assayed by radio-gas chromatography. The carbon atoms react with the substrate while they are hot or after they have reached thermal equilibrium. Oxygen was added as a radical scavenger to minimize radiation damage from the bombardment and also as a specific scavenger for the thermal carbon atoms. Yields of the major products, ^{11}C,-ethylene, ^{11}C-acetylene, and ^{11}C-carbon monoxide were measured. The study confirmed that oxygen functions at low concentration in two roles: as a general radical scavenger, protecting the primary products from radiolytic destruction and as a scavenger for the precursor of ethylene and, to a much lesser extent, acetylene. These functions have opposite effects on the yields and explain the observations of maxima and local maxima in the graphs of ethylene yield and acetylene yield versus oxygen concentration. It was quantitatively demonstrated that, of the 5 systems studied, the effects of radiolysis are greatest in the methane system. Abrupt changes were revealed in the slopes of CO yield and acetylene yield versus percentage oxygen in the middle concentration region. The breaks are rationalized by the onset of a third function of the oxygen: moderator of the hot carbon atoms. In n-butane the yield of CO did not approach 100% at 100% oxygen. Product yields were determined from 14 saturated hydrocarbons in the gas phase with 4.5% oxygen. Measurements on five of these substrates were done for the first time. Remeasurements demonstrated that the values reported for the other 9 compounds were about 25% too low. This disparity was traced to an effect that changes the efficiency of the flow-type counters used in radio-gas-chromatography. The results were used to revise theories relating product yields to the structure of the substrate molecule. Nonparticipation of substrate quaternary carbon atoms in reaction with hot carbon was pointed out and the effect incorporated into the revised structure-yield theories. A new theoretical approach was made towards predicting total yields of hot hydrocarbon products. Two parameters derived from basic theoretical concepts gave very good results. The treatments indicated that rather substantial collision between the hot carbon atom and the substrate molecule is necessary for hydrocarbon production. The degrees of freedom of the substrate molecule was found to be a good measure of its moderating power for hot carbon atoms. (Disser. Abstr.)

12394 RADIOLIZ SERNISTYKH SOEDINENII. CHAST' PERVAYA. (Radiolysis of Sulfur Compounds. Part I). Nanobashvili, E. M.; Chirakadze, G. G.; Simonidze, M. Sh.; Bakhtadze, I. G.; Ivanitskaya, L. V. Tbilisi, USSR, Izdatel'stvo Metsniereba, 1967. 148p.

A brief review is given on the x-, γ-, and mixed (n,γ)-radiation effects on organic and inorganic sulfur compounds. Radiochemical

processes in the sulfur compounds containing hydrosulfide, thiocyanate, and sulfide groups are discussed and regularities in the radiochemical transformation of aliphatic thiols are analyzed as functions of absorbed energy, dosage, concentration, media, and radiation conditions. Extensive references are given for each chapter. (R.V.J.)

Radiochemistry

Refer also to abstract 12266.

12395 (UR-49-867) INCORPORATION OF RADIOACTIVE TRACERS DURING CONTROLLED GROWTH OF MONODISPERSE SILICA PARTICLES. Stoeber, Werner (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). Dec. 5, 1967. Contract W-7405-eng-49. 9p. (CONF-671048-1). Dep. CFSTI.

From 13th Meeting on Bioassay and Analytical Chemistry, Berkeley, Calif.

Tetraalcyl esters of silicic acid in alcoholic solutions react with water in the presence of ammonia in such a way that the hydrolysis of the ester is subsequently followed by a condensation of the silicic acid causing a growth of silica particles. Attempts were made to incorporate radioactive tracers into the bulk of the spheres by inclusion or substitution in the framework of the SiO_4 tetrahedrons during growth of the silica particles. Results for studies of incorporation of ^{134}Cs, ^{54}Mn, ^{65}Zn, ^{124}Sb, and ^{59}Fe are given. (M.C.G.)

Separation Processes

Refer also to abstracts 12225, 12273, 12375, 12476, 12480, and 12500.

12396 (AERE-R-5587) THE SEPARATION, PURIFICATION, MOUNTING, AND COUNTING OF FISSION PRODUCTS. Cuninghame, J. G.; Goodall, J. A. B.; Kitt, G. P.; Webster, C. B.; Willis, H. H. (Atomic Energy Research Establishment, Harwell (England)). Oct. 1967. 83p. Dep. CFSTI. UK 12s 0d.

Procedures for group separation of specific fresh fission products from each other, and from up to gramme amounts of various fissile materials, and procedures for purifying the separated fission products are described. The procedures were developed at AERE over a period of eighteen years. All of them are standard methods used in AERE laboratories. The report also contains sections on carrier preparation and standardization, on source mounting, and on counting. (auth) (UK)

12397 (ANL-7338) THE EBR-II SKULL RECLAMATION PROCESS. PART III. SKULL-OXIDATION EQUIPMENT. Miller, W. E.; Bernstein, G. J.; Fryer, R. M.; Malecha R. F.; Slawecki, M. A.; Paul, R. C. (Argonne National Lab., Ill.). Oct. 1967. Contract W-31-109-eng-38. 32p. Dep. CFSTI.

The fuel discharged from the Second Experimental Breeder Reactor (EBR-II) is an enriched uranium-fissium alloy that is processed by melt refining. The melt-refining process consists of melting the metallic fuel in a zirconia crucible and liquating the material for about 2 hr at 1400°C to remove most of the fission products by volatilization and oxidative slagging. Five to ten percent of the fuel processed in each melt-refining run collects as a residual skull in the zirconia crucible. Pilot-plant work on 20- to 30-g skulls showed that oxidation of the skull with an oxygen-argon mixture at a controlled temperature (700 to 800°C) was a satisfactory procedure for converting the skull to a powder. By this means, a relatively massive skull that adheres to the crucible can be converted to a free-flowing powder that can be poured out with a recovery of about 98%. Plant equipment for oxidizing 400- to 1000-g skulls was developed, installed in the EBR-II Fuel Cycle Facility, and used to process about 300 kg of skull material since its startup. The equipment consists of an electrically heated resistance furnace, an off-gas system, and process controls. The major design problem was to develop a small furnace that would burn the skull with minimum damage to the zirconia crucible. The size requirement was met through the use of an immersion-type heater, which projects into the crucible. Minimum crucible damage was achieved by using a control system that caused the skull to burn at a uniform rate. The activity levels of the volatile fission products from the skull-oxidation furnace were sufficiently low to permit release of the gaseous effluent to the atmosphere through the 200-ft site stack. (auth)

12398 (BNWL-565) WATER FILTRATION RESEARCH. PART III. THE EFFECTS OF POLYELECTROLYTE FILTER CONDITIONERS ON FILTER BED EXPANSION DURING BACKWASHING. Olesen, D. E.; Carlile, B. L.; Schmidt, R. L.; Toulhill, C. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. 17p. Dep. CFSTI.

The Water Filtration Research program showed that as a filter conditioner, polyelectrolyte concentrations, in excess of those employed at the Douglas United Nuclear water treatment plants, are necessary before bed expansion is affected. Graphical data are presented to show the effect of various polyelectrolyte concentrations on filter bed expansion. Theoretical clean bed expansion during backwashing is considered for the laboratory filters and a filter at the 100 D water treatment plant. (auth)

12399 (K-L-1780(Pt.22)) ORGDP FUEL REPROCESSING STUDIES. Progress Report for Period Ending August 31, 1967. Pashley, J. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Dec. 1, 1967. Contract W-7405-eng-26. 22p. Dep. CFSTI.

EGCR pellets were oxidized and then fluorinated in a test to determine how sensitive this UO_2 material is to the control of operating conditions and to uncover possible accompanying flowsheet variations. A simulated fuel element loaded with UO_2 pellets was processed in the semiworks reactor through the decladding and oxidation steps. Filter studies were carried out in volatility process corrosive atmospheres, the sorption of UF_6 on static beds at relatively high gas flow, and BrF_5 compatibility with various materials. Computations were made on the extent of radiolytic decomposition of solid PuF_6 containing an isotropic distribution corresponding to thermal power reactor produced material. Cost estimates for the conceptual plant for reprocessing spent low-enrichment nuclear power reactor fuels were completed. (M.C.G.)

12400 (K-L-6142) FLUID-BED PROCESSING OF UNIRRADIATED URANIUM DIOXIDE REACTOR FUEL ON A SEMIWORKS SCALE. Smiley, S. H.; Pashley, J. H.; Stafford, D. T.; Kaufman, H. L. (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1967]. Contract W-7405-eng-26. 42p. (CONF-671103-2). Dep. CFSTI.

From 60th Annual Meeting of the American Institute of Chemical Engineers, New York.

Volatility process development studies are discussed. A process flow diagram is given and described. The semiworks equipment and operating procedures are considered. Work showed that the HCl decladding and oxidation processes can be accomplished under controlled conditions. Oxidation of the UO_2 proceeded well at 480°C. Heat transfer from pellet bed to wall was quite poor compared to that in the fluidized-bed section. Proper setting and control of the superficial gas velocity through the bed was most important. The minimum required velocity was dependent on pellet bed depth. Attempts to separate the U_3O_8 from most of the alumina to allow transfer of the fuel material to another vessel for fluorination were only partly successful. (M.C.G.)

12401 (Ls-70(Pt.1)) TRIBUTYL PHOSPHATE (TBP) AND ITS APPLICATION IN SOLVENT EXTRACTION. An Annotated Bibliography. Wallach, K. S. (comp.) (Israel Atomic Energy Commission, Tel Aviv). Jan. 1963. 259p. Dep.

References (982) are given to journals, reports, and patents for the period 1940 through 1960. Classified reports mentioned in various published sources are included. (P.C.H.)

12402 (ORNL-4094) UNIT OPERATIONS SECTION QUARTERLY PROGRESS REPORT, OCTOBER-DECEMBER 1966. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 72p. Dep. CFSTI.

Progress is reported in 7 sections and separate obstracts were prepared. (M.C.G.)

For abstracts of individual sections see: 12275, 12276, 12403-12406, and 12747.

12403 (ORNL-4094, pp 5-13) CHEMICAL ENGINEERING RESEARCH. (Oak Ridge National Lab., Tenn.).

The 0.5-scale experimental stacked-clone contactor was tested with a second chemical system, 0.8 M $Al(NO_3)_3$ – 40 vol % TBP in Amsco, to determine whether the advantages of this size still apply when solutions having a slightly higher viscosity are used. At comparable flows, the capacity was even higher at higher viscosities; no decrease in the mass-transfer efficiency was observed. The full-scale stainless steel prototype stacked-clone contactor was tested, using the conditions specified in the Purex flowsheet. Uranium recovery was satisfactory in both the extraction and the stripping modes of operation, representing a uranium processing rate of 60 to 65 kg/day. (auth)

12404 (ORNL-4094, pp 19-27) POWER-REACTOR FUEL PROCESSING. (Oak Ridge National Lab., Tenn.).

Blocks of graphite fuel did not shear evenly; the graphite was

fractured into chunks of random shapes and sizes. Essentially no force was required for the shearing. The 250-ton shear is being modified preparatory to the shearing of fuel sections that were fabricated from Consolidated Edison Core B components. A delayed-neutron monitor, for detecting undissolved fissionable material in sheared fuel pieces, was not able to discriminate the neutron pulses in a strong gamma background. The monitor was modified by installation of 1-in.-thick lead shielding around improved 1-in.-diam BF_3 detector tubes; this version will be tested shortly. (auth)

12405 (ORNL-4094, pp 50-60) FLUORIDE VOLATILITY PROCESSING. (Oak Ridge National Lab., Tenn.).

The Small-Scale Fluidized-Bed Engineering Test Facility was modified to permit decladding tests to be made with either HCl–N2 or HF–O_2 mixtures, oxidation studies to be made at any oxygen concentration, and either bromine pentafluoride or elemental fluorine to be used as fluorinating agents. The decladding of Zircaloy-clad fuel elements with HF–O_2 produced residues containing massive shards of ZrO_2. A large quantity of –325 mesh particles on the filter, which contained 1.3% of the uranium in one run, is believed to be caused by the action of the alumina bed and indicates that the exposure of uranium oxides to the action of the bed should be minimized. Three HCl decladding runs were made with Zircaloy-clad fuel elements. Except for bed spouting in the pyrohydrolyzer, only minor operating difficulties were encountered. (auth)

12406 (ORNL-4094, pp 61-9) MOLTEN-SALT REACTOR PROCESSING. McNeese, L. E. (Oak Ridge National Lab., Tenn.).

Measured relative volatilities of several rare earth fluorides with respect to LiF were approximately 3×10^{-4} at 1000°C. Equations were developed for calculating the buildup of a concentration gradient in the liquid of a semicontinuous distillation system. (auth)

12407 (RFP-832) PLUTONIUM RECOVERY FROM FIBROUS INSULATION AND FIREBRICK. Conner, William V. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Jan. 22, 1968. Contract AT(29-1)-1106. 9p. Dep. CFSTI.

A process using 12N HNO_3 and CaF_2 was developed for recovering plutonium from fibrous insulation and firebrick. The process was developed for both batch and continuous operation. (auth)

12408 (EURFNR-319) INVESTIGATIONS INTO THE DISSOLUTION OF UO_2–Mo NUCLEAR FUELS IN NITRIC ACID. Baehr, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Translation of report KFK-573. 53p. Dep. CFSTI. JCL $5.60 fs, $1.79 mf.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

An abstract prepared from the original of this paper appeared as NSA 22: 2174. (auth)

12409 (NSJ-tr-90) STUDIES ON SEPARATION OF FISSION PRODUCT BY FLOTATION METHOD. SEPARATION OF ^{137}Cs. Koyanaka, Yoshio. Translated for Japan Atomic Energy Research Inst., Tokyo, from Radioisotopes (Tokyo), 15: 77-82(1966). 11p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

An abstract prepared from the original language version of this paper appeared as NSA 20: 16392.

12410 THE FILTRATION OF RADIOACTIVE EFFLUENT PRIOR TO ION EXCHANGE TREATMENT. Clarke, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Soc. Water Treat. Exam., 16: 260-7(1967).

A filtration plant for water purification is described, its development is outlined, and results and experience obtained are reported. The plant is considered to have efficiently filtered radioactive effluent. It is easy to operate and requires very little attention. A total volume of over 1,100 m^3 has been filtered. (P.C.H.)

12411 THE EXTRACTION OF URANIUM(VI) FROM SULPHURIC ACID SOLUTIONS BY DI-n-OCTYLAMINE. Sato, Taichi (Shizuoka Univ., Japan). Bull. Chem. Soc. Jap., 41: 99-105(Jan. 1968).

The partition of uranium(VI) between sulfuric acid solutions and solutions of di-n-octylamine (DOA) in benzene was investigated at different concentrations of sulfuric acid, solvent and aqueous uranium, and at different temperatures. The acidity and the water content of the organic phase, and the effect of the organic solvent on the extraction were also examined. An infrared spectral study was made of the organic solutions. The mechanism of the extraction of uranium from sulfuric acid solutions by DOA is discussed on the basis of the results obtained, and a composition is proposed for the complex formed in this extraction system. (auth)

12412 PROCESSING OF IRRADIATED FUELS. Couture, Jacques; Jouan, Rene. Atompraxis, 13: 553-5(1967). (In German).

The main achievements of the French technique in the field of the processing of irradiated fuels are reported. The main differences and similitudes existing between the Marcoule industrial installations and La Hague's are described. The major trends of the evolution of the processing techniques are outlined, and particular mention made of the tests carried out for the future storage of vitrified fission products. In addition to the main plants, a pilot plant in operation at Marcoule since 1962 that enables the methods used for the processing of natural uranium fuels to be tested on an industrial scale is described. A second pilot plant that has just been completed at La Hague for the study of the processing technique for fuels of fast neutrons reactors and a hot cell for dry process which will soon be in operation at Fontenay-aux-Roses are also described. Reference is made to the contribution of French technique to the realization of the Eurochemic plant at Mol and of the engineering services supplied to Japan for the construction of a processing plant. (auth)

12413 THIN LAYER CHROMATOGRAPHY OF INORGANIC IONS: SELECTIVE SEPARATION OF URANIUM FROM MIXTURES OF RADIOACTIVE FISSION PRODUCTS. Buchtela, K.; Lesigang-Buchtela, M. (Univ., Vienna). Isotopenpraxis, 3: 443-5(1967). (In German).

A specific separation of uranium from radioactive fission products by thin layer chromatography is described. In neutron-irradiated uranium samples, ^{239}Np was detected at the uranium spot after separation. It was identified by gamma spectrometry. (auth)

12414 EXTRACTION OF BENZENESELENINATES OF PROTACTINIUM AND OTHER ELEMENTS BY ISOAMYL ALCOHOL. Myasoedov, B. F.; Pal'shin, E. S.; Molochnikova, N. P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 23: 66-71(Jan. 1968). (In Russian).

The extraction of protactinium benzeneseleninate by isoamyl alcohol from solutions of hydrochloric, nitric and sulfuric acids was studied. The effect of reagent concentration on the extraction of protactinium from 7N H_2SO_4 was investigated. The distribution coefficient of protactinium depends on its concentration. No interference is caused to protactinium extraction into the organic phase by Ni(II), Mn(II), Al, Bi(III), La, Sn(IV), and U(VI) at concentrations of less than 10 mg/ml or by Cr(III), Sb(III), Fe(III), Ti(III), Ti(IV), Th, and Zr at concentrations less than 1 mg/ml. A study was made of the extraction of certain elements from 7N H_2SO_4 by a 4% solution of benzeneseleninic acid in isoamyl alcohol and of the possibility of using this acid for the separation of protactinium from other elements. (auth)

12415 SEPARATION OF AMERICIUM AND CURIUM ON ION EXCHANGERS BY HYDROXYETHYLENEDIAMINETETRAACETIC ACID. III. STUDY OF THE INFLUENCE OF THE CONCENTRATION OF HYDROXYETHYLENETETRAACETIC ACID ON THE SEPARATION FACTOR AND THE EFFICIENCY OF THE COLUMN. Schoumacher, C.; Merciny, E.; Duyckaerts, G. (Univ., Liege). J. Chromatogr., 31: 510-18(Dec. 1967). (In French).

The effects of pH and N-(carboxymethyl)-N-(2-hydroxyethyl)-N,N'-ethylenediglycine (HEDTA) concentration in the eluant on the Am^{3+}/Cm^{3+} separation with a cationic exchanger were studied. At constant HEDTA concentration, in the pH region 2.6 to 2.9, anomalies of the same type as those found in previous work were observed for each cation as far as exchange equilibrium and elution kinetics are concerned. Partition coefficients reached higher values than those expected from the theoretical relationship between K_d and pH, the separation factor fluctuated, and the number of equivalent theoretical plates passed through a sharp maximum. Increase in HEDTA concentration displaced the pH where these phenomena occurred towards a slightly lower value and increased the fluctuation of the separation factor as well as the maximum which characterizes the number of plates. (auth)

12416 DISPLACEMENT CHROMATOGRAPHY ON AN ION EXCHANGER OF CATIONS Mg^{2+}, Mn^{2+}, Fe^{2+}, Co^{2+}, Zn^{2+}, Ni^{2+}, Be^{2+}, Al^{3+}, Cu^{2+}, Ga^{3+}, UO_2^{2+}, VO^{2+}, AND Fe^{3+} AND STUDY OF POSSIBILITIES OF SIMULTANEOUS MEASUREMENTS. Quinche, J. P.; Quinche-Sax, S. (Station Federale d'Essais Agricoles, Lausanne, Switzerland). J. Chromatogr., 32: 162-77(Jan. 9, 1968). (In French).

A technique of displacement chromatography on a strongly acidic cation exchange resin is described, which permits the simultaneous analysis of six cations chosen from the ions Mg^{2+}, Mn^{2+}, Co^{2+}, Zn^{2+}, Ni^{2+}, Be^{2+}, Al^{3+}, Cu^{2+}, Ga^{3+}, UO_2^{2+}, VO^{2+}, and Fe^{3+}, by measuring the space that they occupy in a chromatographic column. The proposed eluent which is a solution of 0.2M triammo-

nium citrate does not, however, allow the complete separation of the groups $Mg^{2+}-Mn^{2+}$, $Co^{2+}-Zn^{2+}$, $Be^{2+}-Al^{3+}-Cu^{2+}$, and $Ga^{3+}-UO_2^{2+}-VO^{2+}$. The use of a cation exchange resin containing a small quantity of morin allowed the simultaneous separation and determination of the cations Mg^{2+} (or Mn^{2+}) $-Zn^{2+}-Be^{2+}$ (or Al^{3+}) $-Ga^{3+}$ without using separating elements. The effects of the cations Li^+, Na^+, K^+, Rb^+, Cs^+, NH_4^+, Ag^+, Tl^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}, Cd^{2+}, Hg^{2+}, In^{3+}, Cr^{3+}, La^{3+}, Y^{3+}, Lu^{3+}, Sc^{3+}, Bi^{3+}, Th^{4+}, and Sn^{4+} on the precision of the analysis were studied. (auth)

12417 PREDICTION OF ELUTION MAXIMA IN THE GRADIENT ELUTION OF RARE EARTHS. Massart, D. L.; Bossaert, W. (Ghent Univ.). J. Chromatogr., 32: 195-200 (Jan. 9, 1968).

A gradient elution technique has been previously reported for use with the ion exchange separation of rare earths using lactic acid as the elution agent. A method for calculating the effects of proposed gradients on the separation was developed. Experimental and calculated distribution coefficients were in reasonably good agreement. The value of the calculations are lessened, however, by the large dependence of K_D on the mass of rare earth brought on the column. Therefore, only the elution maxima of rare earth traces can be predicted. (J.G.B.)

12418 ISOTOPE SEPARATOR ON-LINE STUDIES OF GASEOUS FISSION PRODUCTS. Borg, S.; Faegerquist, U.; Holm, G.; Kropff, F. Ark. Fys., 34: 413-32(1967).

Isotope separator on-line techniques, i.e., continuous production, separation, and detection were applied to study the decay of krypton and xenon fission products. These were pumped from their place of production to the electromagnetic isotope separator. The neutrons were produced by the 225-cm cyclotron or by a 150-kV neutron generator. A moving collector was used in the separator to remove daughter products and contaminants of longer half-life. The equipment and techniques are described and the matter of gas transportation is discussed. (auth) (Sweden)

12419 COMPOSITION OF ZIRCONIUM SOLVATE WITH TRIBUTYL PHOSPHATE. Korovin, S. S.; Dubrovskaya, V. V.; Berezhko, P. G.; Apraksin, I. A. (Moscow State Univ.). Zh. Neorg. Khim., 12: 3128-31(Nov. 1967). (In Russian).

The composition of the Zr solvate formed during its extraction from nitric and sulfuric acid solutions with tributyl phosphate was studied. The results verified that the Zr is extracted in the form of the complex $ZrCl_2 \cdot 2TBP$. Hypotheses on the extraction of the complexes $H_2ZrCl_2 \cdot 2TBP$, $H_2ZrCl_6 \cdot 2TBP$, $H_2ZrOCl_4 \cdot 2TBP$, and $ZrOCl_2 \cdot 2TBP$ do not agree with the data obtained. (tr-auth)

12420 TRANSPORT MECHANISM OF URANIUM IN THE IODIDE PROCESS. Hashino, T.; Kawai, T. (Kyoto Univ.). Trans. Faraday Soc., 63: 3088-3100(Dec. 1967).

The possibility of uranium transport by the van Arkel-de Boer process is discussed in terms of a thermodynamical calculation, and the operating conditions are theoretically deduced. The uranium was successfully transferred under some of these conditions, but not under others. The kinetics of the process were studied under the optimum condition (in a closed transport system with the two temperature regions arranged stepwise). From the deposition rate of uranium the rate-controlling stages, dependent on the total pressure of the system, were determined and it was concluded that the uranium transport was only via the tetraiodide, and the formation rate of the triiodide was so slow that it did not substantially participate in the process. The standard diffusion constant of the gaseous tetraiodide was found to be 3.1×10^{-3} cm^2/sec, and the dependence of the natural convection velocity on the total pressure in the system was evaluated from the experimental data. (auth) (UK)

12421 CARRIER-FREE SEPARATION OF ^{115m}In FROM IRRADIATED Cd BY SOLVENT EXTRACTION WITH 1-PHENYL-3-METHYL-4-CAPROYLPYRAZOLONE-5. Mirza, M. Y. (Pakistan Inst., of Nuclear Science and Tech., Rawalpindi). Talanta, 15: 137-40(Jan. 1968).

A method is presented for the routine milking of the 4½-hr half-life nuclide ^{115m}In from its 2.3 day half-life parent ^{115}Cd. The method utilizes the differential extraction of In and Cd from aqueous solution at various pH values, 1-phenyl-3-methyl-4-caproylpyrazolone-5 in methyl isobutyl ketone being used as extracting agent. A good decontamination factor was obtained, and the yield of ^{115m}In from residual cadmium activity was 85 to 90%. (auth) (UK)

12422 CHEMICAL AND ELECTROLYTICAL DECONTAMINATION OF ALUMINUM CONTAMINATED BY VARIOUS RADIOACTIVE ISOTOPES. Miazek-Kula, Maria. Prace Cent. Inst. Ochrony Pracy, 17: 299-309(1967). (In Polish).

Experiments are described for decontaminating by chemical and electrolytic methods aluminum contaminated by ^{32}P, ^{59}Fe, ^{60}Co, ^{65}Zn, ^{90}Sr, ^{106}Ru, ^{124}Sb, ^{137}Cs, ^{141}Ce, and ^{204}Tl. For electrolytic decontamination an electrolyte consisting of 41% H_3PO_4, 11% H_2SO_4, 6% H_2O, and 42% glycerine and an electrolyte consisting of 55% H_3PO_4, 20% H_2SO_4, 20% H_2O, and 5% CrO_3 were used. The anode process was applied with a current density of 4.4 and 44.4 mA/cm^2 and decontaminating time of 1 to 7 min. For chemical decontamination the same electrolytes were used, as well as 0.2 N H_2SO_4 and water (with a 1 to 7 decontaminating time). By these tests it was determined that the chemical method yields a high degree of decontamination of aluminum contaminated by ^{60}Co, ^{65}Zn, ^{90}Sr, ^{137}Cs, and ^{204}Tl, while this degree is low for contamination by ^{32}P, ^{59}Fe, ^{124}Sb, and, particularly, ^{106}Ru. However, for these isotopes a high degree of decontamination was attained when the electrolytic method was applied. (auth)

12423 SEPARATION OF ZIRCONIUM AND HAFNIUM BY ION EXCHANGE RESIN. Yoshimura, Zenji; Otsuka, Takeshi (Nippon Mining Co., Ltd., Tokyo). Nippon Kogyo Kaishi, 83: 583-5(Mar. 1967). (In Japanese).

A study was made on the separation of Hf from Zr in the system $ZrOCl_2 + HfOCl_2$ by the use of Diaion SK-1 (DVB content is 10 to 20%, 30 to 200 mesh and H^+ form). The separation conditions were investigated with a small column of 30 mm × 800 mm. A solution of $HfO_2/(Zr + HfO_2) = 30\%$ containing 5 g oxide was adsorbed onto a 50 ml resin as much as possible, then adsorbed onto a 150 ml column; it was then eluted with a 1N H_2SO_4. Zr was eluted out in the first 1300 ml, then Hf in the subsequent 1200 ml. Hafnium of 99.9% purity was obtained with a yield of 84%. Using two medium-size columns (100 × 1000 mm), connected in series, the eluent from the first column was passed through the second column; the length of the columns was 90 cm. Zr was eluted out with 1.0N H_2SO_4, and Hf with 1.2N H_2SO_4. Hf of 99.8% purity was obtained with a yield of 99.8%. (NSA of Japan)

12424 VARIATION WITH POTENTIAL OF ELECTROLYTIC HYDROGEN–DEUTERIUM SEPARATION FACTOR ON PLATINUM IN AQUEOUS SULFURIC ACID. Yokoyama, Takamitsu (Hokkaido Univ., Sapporo). J. Res. Inst. Catal., Hokkaido Univ., 15: 84-8(Sept. 1967).

The hydrogen–deuterium separation factor S_f in the electrolytic hydrogen evolution reaction, $2H^+ + 2e \rightarrow H_2$, is defined as $S_f = [V_f(H)]/[(1 - X^s)]/[V_f(D)/X^s]$, where V_f (H) and V_f (D) are, respectively, the forward unidirectional rates of transfer of light hydrogen and of deuterium, and X^s is the atomic fraction of deuterium in aqueous electrolyte. The relationship between S_f and overpotential was studied. Earlier results that the value of S_f near the reversible potential is smaller than the value of the partition coefficient S (4.1 at 15°C) of deuterium between gaseous hydrogen and aqueous electrolyte were confirmed. (J.G.B.)

12425 SEPARATION OF ILMENITE, ZIRCON, AND MONAZITE FROM WESTPORT BEACH SANDS. Nicholson, D. S.; Shannon, W. T.; Marshall, T. (Dept. of Scientific and Industrial Research, Petone, N. Z.). N. Z. J. Sci., 9: 586-98(Sept. 1966).

Mineral separation studies showed that concentrates of ilmenite (45 to 47% TiO_2, not more than 0.03% Cr_2O_3 or 0.04% V_2O_5), zircon (61.1% ZrO_2), and monazite (17.6% Ce_2O_3, 3.9% ThO_2) can be separated from Westport beach sands by conventional gravity, magnetic, and electrostatic processing methods. The beach sand is a natural heavy mineral concentrate containing about 25% ilmenite. Tests indicated that their distinctive magnetic susceptibilities permitted reasonably clean separation of the magnetic, ilmenite, garnet-biotite-monazite, and zircon-quartz-silicate minerals in the beach sands by high-intensity magnetic separation methods. The simplest and most effective flowsheet for processing Westport beach sands involved the following general principles: gravity concentration to reject low-density minerals rapidly, the final gravity stage being tabling with recycling or retreatment of a middle product to produce a final heavy mineral concentrate; magnetic separation of magnetite; drying, followed by electrostatic separation of ilmenite, using recirculation or retreatment to obtain optimum grade and recovery of the ilmenite; and high-intensity magnetic separation of zircon and monazite products, followed by recleaning of these concentrates by gravity or electrostatic methods. The very weak magnetic properties of monazite made its recovery and separation from other weak magnetic minerals and composite grains difficult. An analysis of the monazite concentrate produced is given. Upgrading of the monazite products by flotation may be feasible. (BBB)

12426 ADSORPTION OF RADIOACTIVE MATERIALS BY COAL HUMIC ACID. Matsumura, Takashi; Ishiyama, Toshio. Annu. Rep. Radiat. Center Osaka Prefect., 7: 14-17(1966).

The adsorptive properties of coal humic acid, which was extracted from oxidized coal, were investigated in a batch system

using test liquids containing $^{137}Cs-^{137}Ba$, ^{89}Sr, and ^{60}Co. The performance of the humic acid as an ion exchanger was considerably improved by changing it into the Na-form by pretreatment with NaCl solution. The distribution coefficients were higher for ^{89}Sr and ^{60}Co than for $^{137}Cs-^{137}Ba$ and took satisfactorily high values at the pH range between 4 and 7. The distribution coefficients decreased with increases in competing Na or Ca ion concentration; in the presence of Ca ions of considerably high concentration, the distribution coefficient was higher for $^{137}Cs-^{137}Ba$ than for ^{89}Sr and ^{60}Co. (auth)

12427 SEPARATION OF URANIUM FROM IRON AND OTHER CONTAMINATING METALS. Butler, F. E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Health Phys., 14: 171-2(Feb. 1968).

A liquid ion exchange procedure used at the Savannah River Laboratory is described, based on tertiary amines such as tri-iso-octylamine (TIOA). Data for the extraction of uranium from H_2SO_4 solutions by 10% TIOA-xylene are shown. In tracer experiments >99% of ^{235}U exchanged from 0.5N H_2SO_4 to an equal volume of TIOA-xylene after 10 sec of vigorous shaking. An emulsion formed when the acid was <0.5N. Less than 1% of Fe, Ni, Cr, Zn, and Al exchanged to the TIOA. The uranium is stripped from the organic phase with 0.5N HNO_3. The separated uranium is alpha counted, or reduced to (IV) valence and titrated by standard methods. With regard to decontamination from other actinides, Th and Np do not exchange from 0.5N H_2SO_4, but 80% of Pu is exchanged. Good decontamination from Pu is obtained by extraction from 6N HCl, followed by Pu stripping with 4N HCl/0.02N HF, and U stripping with 0.5N HNO_3. (UK)

12428 IMPROVEMENTS IN OR RELATING TO PRECIPITATION PROCESSES AND APPARATUS. Stevenson, David Gordon (to United Kingdom Atomic Energy Authority). British Patent 1,100,022. Jan. 24, 1968. Filed Oct. 10, 1963.

A precipitation process was developed in which a feed material, disposed in a fluid medium in a form not physically separable from it, is converted by a precipitant material into a precipitate that can be physically separated from the fluid medium. This multistage process can be used for those chemical processes in which the chemical nature of the feed material is changed; for example, the conversion of uranyl nitrate to ammonium diuranate in processes for obtaining uranium from its solutions. It can also be used for those processes in which the physical environment is changed by an added material. Details of the process and apparatus are given. (J.G.B.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 12468, 12537, 12601, 14402, and 14413.

12429 (NP-17230) RADIUMHALTIGA BYGGNADSMATERIAL UR STRALSKYDDSSYNPUNKT. (Radium Containing Construction Materials From a Radiation Protection Point of View). Bergstrom, Stig O. W.; Wahlberg, Thor (Aktiebolaget Atomenergi, Stockholm (Sweden)). Nov. 1967. 24p. (In Swedish). (AES-7).

The radioactivity of different construction materials was determined. Both the existing materials and the ones which may be fabricated from uranium or leach residues were considered. The mean radiation exposure in Swedish housings was determined. The determination was based on assumptions of size and type of housings in 1970 through 2010. The resulting radiation dose increments from leach residue materials was compared with applied international dose recommendations. The increase in dose rate was determined to 5μ·rad/hr. (Sweden)

12430 (SC-CR-67-2708) STUDY OF THE POSSIBLE CONTAMINATION OF GROUND WATER FROM RADIOACTIVE PACKAGES IMPACTING ON LAND. Annual Report, July 14, 1966-July 13, 1967. Schroeder, Melvin C. (Texas Agricultural and Mechanical Univ., College Station); Crocker, Marvin C. Jr.; Blank, Horace R. (Texas Agricultural and Mechanical Univ., College Station. Research Foundation). July 1967. Contracts AT(29-1)-789; 48-4363. 82p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

Radioactive material impacting on land could be leached from the soil by sub-surface water and could enter the ground-water circulation. In the process, however, the radioactive ions might enter into ion exchange with the earth materials, to an extent which depends primarily upon their distribution coefficients with these particular substances. Laboratory investigations of the distribution coefficients of radioactive strontium ions with quartz and with microcline are described, and information gained from the literature on the properties of typical soils and aquifers of the world is summarized. (auth)

12431 (MLM-1470(tr)) SHIFT IN THE RADIOACTIVE EQUILIBRIUM ^{90}Sr AND ^{90}Y IN LAKE WATERS. Sereba, G. A.; Rovinskii, F. Ya. Translated for Mound Lab., Miamisburg, Ohio, from At. Energ. (USSR), 14: 326-7(1963). 5p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The effect of ^{90}Y absorption by lake silts on the equilibrium of ^{90}Sr and ^{90}Y in lake waters was examined. The factors which affect the ^{90}Y absorption are noted and calculations were made for the rate of removal of ^{90}Y from the water. (L.C.L.)

12432 BOREHOLE MODELS FOR NUCLEAR LOGGING. Allen, L. S.; Caldwell, R. L.; Mills, W. R. (Socony Mobil Oil Co., Inc., Dallas). Soc. Petrol. Eng. J., 5: 109-12(June 1965).

Borehole models used in the study of nuclear well logging are reviewed and the merit of heterogeneous vs homogeneous formation simulation is discussed. A heterogeneous model for simulating sandstone formations of variable porosity is described. Simulation adequacy was checked by steady-state and pulsed-neutron measurements. (auth)

12433 GEOCHEMICAL CORRELATION BETWEEN RADIUM-CONTENT ANOMALIES IN UNDERGROUND WATERS AND IN GAS AND OIL STRATA. Gutsalo, L. K. (Inst. of Geology and Geochemistry of Fossile Fuels, Kiev). Dokl. Akad. Nauk SSSR, 172: 1174-6(Feb. 11, 1967). (In Russian).

Up to now, no definite geochemical correlation could be established between the anomalies in the radium concentration observed in underground waters and in oil and gas-containing beds. This problem was examined at the Dneprovs-Donets basin, supplementing the author's earlier reports on the anomalous radium content of the rocks in this area. The radium concentration of stratal waters, not connected with hydrocarbon-bearing beds, was found to depend on the mineral content of the water and the age of the rock but no such connection could be established between the degree of mineralization and the age in waters collected from oil-containing strata. The study indicated that the enrichment of the oil-containing zone is due to the contents of the gas phase. The radium is accumulated as the result of the high vapor pressure of the hydrocarbons dissolved in the stratal waters, as shown by the linear correlation between the radium concentration of the water and the vapor pressure. The increased concentration of radium may be used as an indirect geochemical indicator for oil. (TTT)

12434 ISOTOPIC COMPOSITION OF THE SOVIET VOLCANIC GASES. Cherdyntsev, V. V.; Shitov, Yu. V.; Lizarskaya, I. V. (Geological Inst., Moscow). Dokl. Akad. Nauk SSSR, 172: 1180-2(Feb. 11, 1967). (In Russian).

Earlier studies of the isotopic composition of argon and the radiation-generated argon/helium ratios in natural gases from volcanic regions of the Soviet Union pointed to the prevalence of atmospheric argon; the ^{40}Ar/He ratio was found to be higher than in gases from the Earth's crust. This study was continued by analyzing the volcanic gases collected in Kamchatka and in the Kurile Islands. The He/Ar ratio was found to be lower than the atmospheric ratio, even though the gases from the crust were often enriched in helium. It was concluded that the gases probably consist of residues from atmospheric air with low radioelement concentrations; the low potassium concentration is due to the absence of radiation-generated argon. The gases are characterized primarily by their ^{36}Ar content, indicating an age of not less than 1 billion years. The crust gases, examined for comparison, exhibited a high He/Ar ratio, large amounts of atmospheric argon and a low ^{40}Ar/He ratio which never exceeded 0.075; the highest value found in nonvolcanic gases in the Soviet Union for this ratio was 0.081. (TTT)

12435 A REVIEW OF RADIOISOTOPE METHODS OF STREAM GAGING: REVIEW PAPER. Ellis, W. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Hydrol., 5: 233-57(Sept. 1967).

Various radioisotope methods used to measure the flow of streams and rivers, particularly under Australian conditions are reviewed. Selection of a radioisotope, mixing length, adsorption, equipment, calibration, and safety are discussed. The possibility of a significant hazard exists in stream gaging only during and immediately before and after the injection of the radioisotope into the stream. The amount of radioisotope required for gaging is small in relation to the flow; its concentration is rapidly reduced by dilution to below that of the maximum permissible average life-time drinking water tolerance. Pertinent data for various isotopes suitable for stream gaging are tabulated. It is shown that for ^{82}Br, ^{198}Au, and ^{64}Cu the maximum concentration at the point of complete mixing need only be a small fraction of the permissible average life-time drinking water tolerance for the general public. For tritium, the ratio is less than one half. Expressions for determining the maximum allowable radiotracer injections for flow rate measurements in public streams are given, for a single pulse injection as used in the total count and continuous sample gaging methods. Various methods of gaging are compared for speed, accuracy, and convenience of field operation, over as wide a range of conditions as possible, e.g., varying stream velocities, total flows, and river configurations. Stream gaging methods are being developed to the point where they can be applied with confidence to a wide variety of conditions in Australia. (BBB)

12436 ^{210}Pb AND ^{90}Sr IN AN ALPINE GLACIER. Picciotto, E. (Univ. Libre, Brussels); Crozaz, G.; Ambach, W.; Eisner, H. Earth Planet. Sci. Lett., 3: 237-42(Dec. 1967).

^{210}Pb and ^{90}Sr measurements were carried out on firn and ice samples from the Kesselwandferner (Austrian Alps). ^{90}Sr seems to be selectively lost in the firn with respect to the other fission products and to ^{210}Pb. The distribution of the ^{210}Pb 'ages' of the ice samples follows a consistent pattern and is in general agreement with surface velocity measurements. (auth)

12437 RADIOGRAPHIC METHOD OF DETERMINING THE DIRECTION OF GROUND WATER FILTRATION IN DRILL HOLES. Niemczynowicz, Janusz; Frazek, Edward (Hydrogeological Enterprise, Warsaw). Nukleonika, 12: 1041-6(Nov. 1967).

A new method for determining the direction of ground water flow in drill holes making use of the radiographic method is described. The role of the radiation detector in this technique utilizes a highly sensitive x-ray film. Experiments involving hydrogeological models have been carried out to select the optimum working parameters for the method and to compare the results obtained with the radiographic method with those obtained with a slot method. (auth)

12438 RETENTION OF ^{137}Cs BY SEVERAL CLAY MINERALS. Ojima, Tsutomu; Toratani, Hirokazu; Fujimoto, Hiroshi. Annu. Rep. Radiat. Center Osaka Prefect., 7: 79-85(1966).

Cesium retention was measured by treating suspensions of several clay minerals with a ^{137}Cs-labeled solution. The amount of cesium adsorbed by clays was distributed among three phases: exchangeable, 1N nitric acid soluble, and insoluble fixed. The

greater amount of cesium was retained by vermiculite and illite. Cesium retained by vermiculite was trapped in the lattice by ammonium or potassium ions of the extracting solution. Cesium retained by illite could substitute for interlayer potassium and was fixed tightly. Sodium salts appeared to be the most suitable extractant for the cation exchange studies with the 2:1 layered-type clay minerals. (auth)

Meteorology

Refer also to abstract 12469.

12439 (AERE-R-5575) RADIOACTIVE FALLOUT IN AIR AND RAIN: RESULTS TO THE MIDDLE OF 1967. Cambray, R. S.; Fisher, E. M. R.; Brooks, W. L.; Peirson, D. H. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1967. 49p. Dep. CFSTI. UK 7s. 0d.

Samples of atmospheric dust and rainwater were collected from the United Kingdom and elsewhere. Results are presented of the analyses of these samples for various fission products and certain other radionuclides. The concentrations of the long-lived fission products ^{137}Cs and ^{90}Sr in air and the deposition by rain in the United Kingdom were, in the first half of 1967, about 50% of those for the first half of 1966. During the last few months of 1966 the reduction by radioactive decay exceeded the deposition rate of ^{90}Sr so that, for the first time, the cumulative deposition in the United Kingdom began to decrease with time. Deposition again slightly exceeded radioactive decay during early 1967. About one-tenth of the long-lived fallout in early 1967 was contributed by the Chinese explosion of December 28, 1966. This increase was sustained for several months, because debris had been injected into the stratosphere. No short-lived fission products (such as ^{131}I) from the Chinese explosion of June 17, 1967, were detected in the United Kingdom, although there is evidence in the autumn of 1967 of debris from this explosion. An estimate is made of the global deposition of ^{90}Sr in rain to the end of 1966. Plutonium-238 from the burn-up of a satellite in 1964 was detected in surface air in the United Kingdom. Measurements of short-lived fission products from the Chinese explosions of October 1966, December 1966, and June 1967, and the French tests of May to June 1967, are given in an appendix. (auth)

12440 (FOA-4-4329-28) THE DYNAMICS OF THE EXPLOSION CLOUD. I. A THEORETICAL MODEL FOR NUMERICAL CALCULATION OF THE THERMODYNAMIC PROCESSES DURING THE CLOUD DEVELOPMENT. Rydgren, B. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Jan. 1968. 35p. Dep.

Studies on the physical-meteorological factors, which affect the development of the explosion cloud are discussed. The main purpose was to describe the thermodynamic processes, starting from a point corresponding to a mean cloud temperature of about 1000 to 1500°K. Factors were studied, which influence the cloud temperature–radiation, adiabatic cooling and entrainment from the ambient air. Concerning the adiabatic changes of temperature above the condensation level, a special model was applied which permits the calculation of the total water content of the cloud. The distribution of the vertical velocity was also obtained, from the temperature functions. It gave a rough time scale for the different phases of the cloud development. The results were derived for constant height intervals by numerical data processing applied to the basic differential equations. The numerical calculations were performed on an IBM 7090 computer. The program permits a great variation of the initial and the meteorological data. (auth)

12441 (FOA-4-4494-28) MATNINGAR AV FORHOJD AKTIVITET I MARKLUFTEN, DECEMBER 1966. (Detection of Increase in Radioactivity of Ground Air, December 1966). Persson, G. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Oct. 1967. 14p. (In Swedish). Dep.

During the period between December 22 through December 30, 1966, an increase of the radioactivity was detected in surface air and in precipitation in Sweden. This was especially the case in the northernmost part of Sweden. Analysis of the samples showed that a few compounds in the natural ground aerosol dominated the amount of radioactivity. Together with meteorological calculations this proves that the origin of the radioactivity was an underground nuclear weapon test at Semipalatinsk, December 18, 1966. (Sweden)

12442 (LA-3787) RADIATION MEASUREMENTS OF THE EFFLUENT FROM THE PHOEBUS 1B REACTOR. Larson, Oliver W.; Smale, Richard F. (Los Alamos Scientific Lab., N. Mex.). Sept. 1967. Contract W-7405-eng-36. 25p. Dep. CFSTI.

Effluent cloud composition and air radioactivity concentration, as determined by analysis of samples collected downwind during the Phoebus 1 B full power test, are presented. Dose due to cloud passage as determined from air samples is compared with that determined by other measurements. Sampling procedures and equipment are also described. (auth)

12443 AN ANALYSIS OF LONG-TERM OBSERVATIONS OF ^{90}Sr DEPOSITION. Sotobayashi, Takeshi; Suzuki, Toshio; Kanda, Yukio (Niigata Univ., Japan). Bull. Chem. Soc. Jap., 41: 246-7 (Jan. 1968).

An analysis of long-term observations of ^{90}Sr is presented and cumulative deposition of ^{90}Sr per unit of area per unit of the activity produced by a series of atmospheric nuclear fission events is estimated. Data for the monthly deposition of ^{90}Sr and its specific activity at Niigata during 1965 to 1966; the yearly total of ^{90}Sr deposition and the yearly decreasing rate (1960 to 1966); and the estimated ten-year total of ^{90}Sr deposition and its ratio to total ^{90}Sr activity produced are tabulated. (D.H.M.)

12444 LOCAL INFLUENCES ON ARTIFICIAL RADIOACTIVITY IN THE BIOSPHERE. Marquardt, W. (Karl-Marx-Univ., Leipzig). Kernenergie, 10: 276-81 (Sept. 1967). (In German).

Local parameters influence the contamination of the biosphere. Inversions stop the supply of fission products from the atmosphere. Many aerosols are bound by fog. Fog particles precipitate when meeting with obstacles; the near-ground air is partially decontaminated. Radioactive fallout depends on duration and kind of atmospheric precipitations. Wind pick-up effects may locally intensify the radioactivity of air. Therefore, the results of measurements made in one place cannot be directly transferred to neighboring places. (auth)

12445 STRATOSPHERIC RADIOACTIVITY MEASUREMENTS RELATED TO THE FIRST CHINESE H-BOMB TESTS OF JUNE 17, 1967. Fett, Walter (Freie Univ., Berlin). Berlin. Wetterkarte, Suppl. 155/67, 6p (1967). (In German).

Stratospheric radioactivity over ranges from 3 to 300 mb were measured by probes carried aloft in balloons in an area 6.5 to 22 km west of Berlin. The results were compared for their statistical validity to eliminate sensitivity differences between the measurement probes used. Compared to fission product activity measurements made in the region of Rome, the activity near Berlin was ~½ as great. Plots of time-altitude isopleths of the count rates measured over Berlin and Rome during the first passage of the H-bomb cloud and the lower measurement boundary for the eccentricity of the cloud distortion at the time of the passage of the maximum over Rome are presented. The differences between the results obtained at Berlin and Rome are reconciled by the author. (BBB)

12446 RADIOACTIVITY MEASUREMENT RELATED TO THE FIFTH RED CHINESE ATOM BOMB TEST OF 12/28/66. Fett, Walter (Freie Univ., Berlin). Berlin. Wetterkarte, suppl. 57/67, 6p (1967). (In German).

Within 8 days following the explosion of the 300-kt Red Chinese atomic bomb, measurements were made with a counting tube at a height of over 30 km above Berlin. The vertical path of the probe temperature, and wind velocity are illustrated, along with the average counting rate and error. The vertical path of the radiation increment is traced. The max of ~1.5 pulses/sec corresponded to 15% of the activity found at 280 mb at ~100 mb above the tropopause, with 50% of the radiation increment located within a layer of ~1.2 km. From this, a β activity concentration of 46 pCi/g air or 2×10^5 pCi/m^3 was estimated. A plot of the approximate trajectory path of the explosion at the 300 mb level is shown. Rain on Jan. 7, 1967, did not contain any fresh fission products, but did on Jan. 10, 1967. The first radioactive particles were detected in the surface air on Jan. 10, 1967, but the greatest portion was detected from Jan. 17, 1967 on. Calculations indicated that the time for the activity max to circle the earth at the lower stratospheric level was ~18 days, as compared to 20 days for the third test. (BBB)

12447 TUNGSTEN RADIOISOTOPE DISTRIBUTION AND STRATOSPHERIC TRANSPORT PROCESSES. Martell, E. A. (National Center for Atmospheric Research, Boulder, Colo.). J. Atmos. Sci., 25: 113-25 (Jan. 1968).

Analysis of radioisotope production data for the 1958 HARDTACK nuclear tests at 11N indicates a main source near 20 km altitude and another source of different radiochemical composition near 30 km altitude. Aircraft and balloon sample measurements confirm this distribution of sources and show features in the poleward and downward transport of the upper source. Radioactive tracers give evidence for mean motion downward into the lower tropical stratosphere accompanying the downward propagation of westerlies in July 1959 and again in September 1963. The apparent equatorward drift of the ^{185}W concentration maximum

is explained not by mean motion but by selective erosion of the northern part of the source due to a rapid increase in the intensity of meridional eddy-mixing with latitude in the tropical stratosphere. Evidence is presented suggesting that the poleward transport of the upper source near 30 km proceeds along mixing surfaces sloping downward toward higher latitudes. Other details of the redistribution and transport of the radiotungsten tracers in the stratosphere and lower atmosphere are considered. (auth)

12448 A STUDY OF THE RADIUM ALPHA ACTIVITY OF COAL, ASH, AND PARTICULATE EMISSION AT A SYDNEY POWER STATION. Bayliss, R. J.; Whaite, H. M. (New South Wales Dept. of Public Health, Sydney). Air Water Pollut., 10: 813-19(Nov.-Dec. 1966).

Radium α activity was determined in samples of coal and ash from Pyrmont Power Station (Sydney) to estimate the potential health hazard to the general population. Four International Combustion boilers each burn 500 t/day of pulverized coal at full load. Dust collectors, of Lodge-Cottrell type, are 92.4% efficiency by weight. About 5% of the ash passes up the stack as fly ash; ~17 t of ash escape into the atmosphere each day at full load. Radioassay showed that the α activity of the fly ash was double the average value for the collected ash. The fly ash fraction is the one to which the surrounding population is exposed. It was estimated to contain 14 pCi/g. It is considered that the average respirable dust concentration would not exceed 0.003 mg/m^3. Since the sp act. of the fly ash is 14 pCi/g, and if it is assumed that the α activity is uniformly distributed throughout the fly ash, the α activity concentration would be $\sim 4.2 \times 10^{-5}$ pCi/m^3, or 4.2×10^{-17} μCi/cm^3 of air. It is concluded that this constitutes a negligible radiation hazard. Under the New South Wales Radioactive Substances Act, the maximum permitted concentration for airborne radium (insoluble) for continuous exposure of the population-at-large is 2×10^{-9} μCi/cm^3, in agreement with that recommended by the International Commission on Radiological Protection. (BBB)

12449 BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY, NO. 47, OCTOBER-DECEMBER 1966. Taiki Hoshano Kansoku Seiseki, No. 47, 1-72(Oct.-Dec. 1966). (In Japanese).

Data are tabulated for the quarter concerning measurements of temporary standard sample (U_3O_8) at each station, summary of mean radioactivity in rain collected at fixed time daily, observed radioactivity in rain collected at fixed time daily, observed radioactivity in airborne dusts, radioactive measurements in sea water, and radioactive measurements of rain water and falling dust. (J.C.W.)

12450 HIGHLY RADIOACTIVE FALLOUT PARTICLES FROM THE THIRD CHINESE NUCLEAR TEST EXPLOSIONS. II. Mamuro, Tetsuo; Matsunami, Tadao; Fujita, Akira. Annu. Rep. Radiat. Center Osaka Prefect., 7: 5-13(1966).

The radionuclide fractionation appearing in the highly radioactive fallout particles from the third Chinese nuclear test explosion of May 9, 1966 was investigated by gamma spectrometry. Activities of ten radionuclides, ^{95}Zr, ^{97}Zr, ^{99}Mo, ^{140}Ba, ^{141}Ce, ^{143}Ce, ^{144}Ce, ^{147}Nd, ^{237}U, and ^{239}Np, were determined and the initial atom number of each nuclide contained in each sample was calculated; furthermore, in order to express the degree of fractionation, the fractionation factor defined with respect to ^{95}Zr was calculated. The twenty-one radioactive particles subjected to investigation individually were isolated from the accompanying nonradioactive dust particles and their color microphotographs taken in order to measure their diameters exactly and to examine their colors and shapes. The results obtained are discussed with respect to the following items: the relation between the initial atom number and the particle volume, the relations between the fractionation factors, dependence of the radiochemical composition on the chemical composition of the matrix material, comparison of the radiochemical compositions of the particles with those of the rainwater samples, and comparison of the present radioactive particles with ones formerly studied. (auth)

12451 HIGHLY RADIOACTIVE FALLOUT PARTICLES FROM THE THIRD CHINESE NUCLEAR TEST EXPLOSION. I. Fujita, Akira; Matsunami, Tadao; Mamuro, Tetsuo. Annu. Rep. Radiat. Center Osaka Prefect., 7: 1-4(1966).

Many highly radioactive fallout particles were found and collected shortly after the third Chinese nuclear test explosion of May 9, 1966. All the particles examined were almost spherical and brown, yellow, or colorless. The particle radioactivity was roughly proportional to the third power of the particle diameter and the particle density ranged from 5.2 to 6.5 g/cm^3. The lightly colored particles tended to be smaller in density than the darkly colored ones. (auth)

12452 RADIOCHEMICAL AND PHYSICAL CHARACTERISTICS OF SINGLE FALLOUT PARTICLES. Rao, M. N.; Yoshikawa, K.; Thein, M.; Clark, R. S.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Health Phys., 14: 135-9(Feb. 1968).

Highly radioactive single fallout particles from the third Chinese nuclear explosion in May 1966 were identified by means of autoradiography and G-M counting of rain and air-borne dust samples collected at Fayetteville, Arkansas, and Osaka, Japan. Several characteristic features, including color, diameter, and gross-beta activity of these particles, were measured and a correlation between the particle diameter and its β activity was found. γ measurements revealed that the single particles were enriched in refractory, and were depleted in volatile, radionuclides. From the radiochemical measurements the concentrations of several nuclides in these single particles were determined and the corresponding fractionation factors were calculated. (auth) (UK)

12453 ACCUMULATION OF FISSION PRODUCTS ON THE EARTH'S SURFACE IN THE REGION OF LENINGRAD FROM 1954 TO 1965. Gedeonov, L. I.; Gritchenko, Z. G.; Zhilkina, M. I.; Flegontov, V. M. At. Energ. (USSR), 23: 358-9(Oct. 1967). (In Russian).

Radioactive fallout of ^{89}Sr and ^{90}Sr, ^{137}Cs, ^{144}Ce-^{144}Pr, ^{106}Ru and ^{95}Zr-^{95}Nb was measured. The total activity showed a maximum of 0.8 curies/km^2 in 1959, fell to a minimum of 0.25 curies/km^2 in 1961, rose to a maximum of 1.8 curies/km^2 in 1963, and declined to 0.55 curies/km^2 at the end of 1965. The short-lived isotopes ^{89}Sr, ^{91}Y, ^{103}Ru and ^{141}Ce and ^{95}Zr-^{95}Nb rapidly attained their maxima, and then decreased due to radioactive decay after the cessation of nuclear testing. A slow decrease in ^{106}Ru and ^{144}Ce activities was observed when radioactive decay of these isotopes on the earth's surface exceeded the fall-out (1960 to 1961 and 1964 to 1965). The accumulation of ^{137}Cs and ^{90}Sr is still rising slowly. The levels were about 85 mc/km^2 for ^{137}Cs and about 40 mc/km^2 for ^{90}Sr at the end of 1965. If no additional activity is added to the atmosphere, a decrease in the ^{137}Cs and ^{90}Sr fallout can be expected to occur in the near future. (TTT)

Mineralogy and Exploration

Refer also to abstract 12487.

12454 MICROSCOPIC SIMILARITIES BETWEEN CERTAIN THUCHOLITES AND HUMIC CARBONACEOUS MATERIALS. Jedwab, Jacques (Univ. Libre, Brussels). Bull. Soc. Fr. Miner. Crist., 89: 251-8(1966). (In French).

Thucholites originating in Wallingford Mine, Quebec; Besner Mine, Ontario; and Boliden, Vesterbotten, Sweden show structures by reflection microscopy which are similar to those of humic constituents of coals and lignites (La Chapelle-sous-Dun, Saone et Loire, France). The classical genetic theory of thucholites is criticized, in which these materials would result from radiative polymerization of fluid hydrocarbons. The thucholites chosen for study do not occupy a special position in U-C associations, but are products of the supergenic carbonaceous material cycle. The existence of structures of humic materials in certain thucholites, but not all, is an indication of the diverse origin of these materials. Radioactive elements did not play a decisive role in the deposition of humic carbonaceous material, because similarities are found with samples where such elements are absent. Radiation effects have probably been the reason for their conservation. Illustrations of microphotographs of ribbon structures in thucholites and fissured vitrites in humic material are given in support of the thesis. (BBB)

Oceanography

Refer also to abstracts 14375, 14411, and 14412.

12455 (EUR-3635) STUDIES ON THE RADIOACTIVE CONTAMINATION OF THE SEA. Annual Report, 1966. Bernhard, M. (Comitato Nazionale per l'Energia Nucleare, La Spezia (Italy). Laboratorio per lo Studio della Contaminazione Radioattiva del Mare). Dec. 1967. 30p. (RT/BIO-(67)35). Dep.

A program is described for studying the factors which influence the uptake, accumulation, and loss of radioisotopes by marine organisms. This program includes both a survey of the elements and factors in a sampling area, and experiments on the influence of environmental factors on the uptake, accumulation and loss of radioisotopes by marine organisms in relation to the data obtained in the survey. The results obtained in 1966 are given. (auth)

12456 (PG-Report-819) SOME ASPECTS OF THE CHEMISTRY OF RUTHENIUM IN SEA WATER. Wilson, P. D. (United

Kingdom Atomic Energy Authority, Sellafield (England). Production Group). 1968. 10p. Dep. CFSTI. UK.

The effluent discharged to sea from the Windscale Works contains radioruthenium both in solution and in the form of a co-precipitate with ferric hydroxide. Laboratory experiments on synthetic ruthenium solutions indicate that in sea water an equilibrium is set up between cationic, anionic, and perhaps neutral ruthenium complexes. Ruthenium is therefore taken up by both anion- and cation-exchangers, and by the polysaccharide porphyran, which is a major constituent of the edible seaweed Porphyra. It is also absorbed strongly by ferric hydroxide particles. In all cases the extent of sorption increases slowly over a period of weeks or months. Ruthenium co-precipitated with ferric hydroxide is only superficially leached by sea water. Since, after ageing, the particles become resistant to acid, ruthenium in this form is not a serious source of contamination to the tissues of marine organisms. (auth) (UK)

Seismology

Refer also to abstracts 12459 and 12470.

12457 (NVO–1163-80) MAGNIFICATION OF LOVE-WAVES. Schultz, Abraham (Environmental Research Corp., Alexandria, Va.). Oct. 13, 1967. Contract AT(29-2)-1163. 28p. Dep. CFSTI.

Consistent variations in seismic signal strength, resulting from NTS events, along the southeast line to Las Vegas have been observed for some time. It has been assumed that these variations were somehow connected with the changes in thickness of the alluvial layer. An attempt to give a quantitative explanation of these variations resulted in the development of a general theory of Love-wave magnification. Given that two stations both record a Love-wave, this theory enables one to relate the relative signal strength between the two stations to the layering structure beneath the stations. Reasons are given for assuming that the low frequency transverse component is a Love-wave. Comparisons are made between experimental and theoretical values of magnification for the events Cup, Kestrel and Wagtail at stations SE-3, SE-4, SE-5 and SE-6. Because the elastic constants and layered thicknesses which are used as input to the mathematical model are not accurately known, it is difficult to evaluate the utility of this model with regard to the prediction problem. Acquistion of physical properties measurements is planned for further studies on the general question of magnification of surface motions. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 12440, 12441, 12453, and 14410.

12458 (MSAR-67-187) INVESTIGATION OF METHODS FOR ARRESTING DETONATIONS IN GAS MIXTURES. Final Report. Samuel, W. A.; Greer, J. S.; (and others) (MSA Research Corp., Evans City, Pa.). Nov. 2, 1967. Contract W-7405-eng-48. 61p. Dep. CFSTI.

For California Univ., Livermore. Lawrence Radiation Lab.

An investigation of methods for inhibiting and arresting detonations in H–O systems is reported. An inhibition-arresting system has been evolved that should cost less than one-seventh as much as air dilution. The projected comparative costs are $800,000 versus $4,850,000. When a simulated cavern effluent was diluted with steam to approximately one and three-quarter times its original volume, it would not detonate. The resulting H_2 concentration was 17.5%, and although a flammable mixture, a bubbler with only nine inches of water head was effective as a flame barrier. Although the original work statement called for handling gas containing particulates, it was pointed out that a caustic scrubber at the cavern outlet would remove this requirement. Several processing schemes were evaluated to show the relative savings possible for the gas treatment unit. In the most economical process, the cavern effluent, after passing through a bubbler, is diluted with a recycle stream of its own combustion products. The burner effluent is split into two streams: one is the recycle, the other passes to a condenser. If the gas mixture is cooled to 200°F, the material entering the gas processing unit will be comprised of only 100 SCFM of nitrogen and water vapor. Other diluents tested included methane, propane and acetylene. All inhibit detonation at sufficient concentrations, but the mixtures still are flammable. Flame speeds for all such mixtures were measured dynamically and/or statically. Comparative costs were calculated. Some tests were also made with wire arrestors and with baffle chambers. None showed promise. (auth)

12459 (NVO-99-30) DYNAMIC CHARACTERISTICS OF MULTISTORY BUILDINGS. Blume, John A. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Jan. 1968. Contract AT(26-1)-99. 44p. Dep. CFSTI.

To evaluate unit stresses or to estimate possible damage in multistory buildings from ground motion due to an earthquake or an underground nuclear explosion, it is essential to determine how much of the dynamic response at any level is due to various types of freedom. The effects of shear deformation between floors, joint rotation, overall flexure, and ground compliance are considered. Joint rotation and overall flexure are evaluated over a wide range of building characteristics with simply determined indices. A Period Synthesis concept and a Pseudo Stiffness Procedure are proposed to enable the determination of periods, mode shapes, and stiffnesses with consideration of joint rotation, overall flexure, and ground compliance while performing simple labor-saving analyses for assumed rigid-floor shear buildings. The first three modes of vibration are considered in elastic free vibration. The buildings and models are symmetric in plan without torsional coupling. (auth)

12460 (NVO-1163-78) THEORETICAL ANALYSIS OF THE THREE ZONE MODEL. Gorman, Richard L. (Environmental Research Corp., Alexandria, Va.). May 23, 1966. Contract AT(29-2)-1163. 106p. Dep. CFSTI.

The theoretical development of the three-zone model is treated. The model consists of an inner gaseous region, an intermediate zone which is assumed to have liquid properties, and an elastic region which is treated as an elastic solid. Apart from corrections due to the departure of cavity shape from sphericity, the model assumes spherical symmetry. The theory covered is based on linear elastic theory. Considerations have been made regarding variations in yield, effects of permanent compression, departure of cavity shape from sphericity, energy dissipation, etc. A linear theoretical description of the wave shape entering the elastic region from the cavity is made possible using only direct input parameters such as yield, elastic parameters of surrounding rock, etc. Nonlinear effects do occur in practice and existent shock-theoretical developments make use of these effects. The theory discussed in this report considers a wave form throughout the propagation medium and includes cavity resonances. Both shock theory and the theory using the three-zone model have their advantages and disadvantages. The theory developed here considers the processes occurring near the cavity in an underground nuclear explosion. (auth)

12461 (PRNC-110) PUERTO RICO NUCLEAR CENTER PLOWSHARE WORKSHOP, JULY 1–AUGUST 15, 1967. Pedersen, Knud B. (ed.) (Puerto Rico Nuclear Center, Mayaguez). Contract AT(40-1)-1833. 137p. Dep. CFSTI.

A six week workshop was conducted at the Puerto Rico Nuclear Center, starting July 1, 1967, to provide a complete background for its scientific staff and the University of Puerto Rico faculty members on the scientific bases, phenomenology, engineering principles, and constructive uses of nuclear explosives. A graduate course in nuclear civil engineering will evolve from this background material. Tables are presented of reference literature, the lecture topics, and the titles of 52 lectures. The appendixes present some lectures related to nuclear explosions and cover a variety of subjects including seismic waves and elastic theory, procedures for developing construction projects, and applications of nuclear explosions for canal and harbor excavation, gas production and stimulation, oil recovery, mining, salt water distillation, and commercial radioisotope production. (L.C.L.)

12462 (SC-DC-67-2330) PHOTOGRAMMETRIC TECHNIQUES ASSOCIATED WITH MODEL STUDIES OF EARTH-MOVING EXPLOSIONS. Love, George C.; Vortman, Luke J. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 38p. (CONF-680203-1). Dep. CFSTI.

From American Society of Civil Engineers Transportation Conference, San Diego, Calif.

The possible future use of nuclear explosives for large-scale excavation projects has led to small-scale investigation of cratering and ejecta mechanisms using chemical explosive charges. Photogrammetric techniques have been developed which enable rapid accurate measurement of crater dimensions. Ground-supported stereo photography is utilized before and after explosions for mapping with contour lines at 0.2-foot intervals and spot elevations at 0.1-foot accuracy. A similar technique with a horizontal line of sight is used to locate in three dimensions gages which measure geometry and strength of the blast wave as it vents from the ground. Information obtained from these experiments will guide further testing and be instrumental in determining placement and charge sizes for nuclear explosive earth moving. Other applications of these photogrammetric techniques are possible. (auth)

12463 (UCID-15251) SOME LONG-TERM ENVIRONMENTAL HEALTH ASPECTS OF THE ENGINEERING APPLICATIONS OF NUCLEAR EXPLOSIVES. Whipple, G. Hoyt (California Univ., Livermore. Lawrence Radiation Lab.). June 7, 1967. Contract W-7405-eng-48. 13p. Dep. CFSTI.

The release of tritium, ^{85}Kr and ^{14}C to the environment by underground nuclear explosions has been considered as an equilibrium situation and compared to the release of tritium and ^{85}Kr by nuclear power reactors. A portion of the world environment has been taken as the United States' share. The three radioisotopes are presumed to reach the environment and equilibrate throughout it in periods shorter than their half-lives. Out of respect for multiple undertakings that will release radioactive material, for multiple radioisotopes from each undertaking, and for the impossibility of measuring public exposures, estimates have been based on $^1/_{100}$ of the public maximum permissible concentrations and daily intakes (equivalent to 0.005 rem per year) for each isotope for each type of undertaking. On these bases, it is estimated that for the United States, nuclear power generation is limited by ^{85}Kr to 100,000 MW(e), and nuclear detonations are limited by ^{14}C to 170 Mt per year. Corresponding limit concentrations in natural gas released by nuclear explosions are tritium 5×10^{-8} μCi/cc, ^{85}Kr 1×10^{-6} μCi/cc, and ^{14}C 4×10^{-8} μCi/cc. (auth)

12464 (UCRL-50334) NUCLEAR OPERATION: PROJECT GASBUGGY. Woodruff, Wayne R. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 19, 1967. Contract W-7405-eng-48. 9p. Dep. CFSTI.

The nuclear-operation portion of a Gasbuggy-like experiment is described. Included are the planning and design required for the selection and containment of the explosive, specifications for the arming and firing cable, preparation and construction of the test hole, and the procedures used for emplacement, arming, detonation, and post-shot radiation safety monitoring. (L.C.L.)

12465 (UCRL-50360) RESIDUAL TRITIUM AT SEDAN CRATER. PART II. SOIL AND EJECTA STUDIES. Koranda, John J.; Martin, John R.; Wikkerink, Robert (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 7, 1967. 42p. Dep. CFSTI.

Continuing studies of residual tritium in soil or ejecta deposited on the landscape around the Sedan crater, Nevada Test Site, are

concerned with the spatial and temporal distribution of THO in the area from the crater lip to 5000 ft from ground zero. Seasonal variations in the concentrations of tritium in soil water occur mainly during the winter rainfall period. Dilution effects were observed to a depth of 3 ft during an unusually high rainfall period (1965 to 1966). Diluted tritium concentrations in the surface strata of soil (6 in. to 3 ft) increase to almost the predilution levels during the summer as a result of soil moisture movements. When Sedan ejecta occurs as a shallow layer overlying the preshot soil, maximum tritium concentrations are found in this soil, usually at the maximum depth of rainfall penetration, or approximately 3 ft. Maximum concentration of tritium in ejecta on the Sedan crater lip is found at a depth of 4 to 5 ft and is correlated with the depth of ejecta materials found around the crater lip. An inventory of tritium in the Sedan ejecta field was calculated, based upon collections of soil samples along transects of the ejecta-covered area, and to a depth of 6 ft at each site. The tritium inventory measurements are essentially of biologically available water in the soil system. When data are corrected to total soil-water tritium values, the current inventory of tritium outside the Sedan crater in 1967, five years postshot, is 5 to 6% of the estimated inventory of the residual tritium in the ejecta at shot time. (auth)

12466 (UCRL-Trans-10152) THE THERMONUCLEAR "BULLDOZER" WILL SOON BE IN USE. Use of Nuclear Bombs to Carry Out Large Engineering Projects Previously Thought Economically Impossible. Roy, Jean-Rene. Translated by Robert Addis for Univ. of California, Lawrence Radiation Lab., Livermore, from Jeune Sci., 5: 36-41(1966). 24p. Dep. CFSTI. JCL $2.60 fs, $0.92 mf.

The use of nuclear explosions in excavations is discussed. The USAEC's Plowshare Program for the utilization of nuclear explosives for peaceful purposes is described. Hazards of radiation and shock waves are also described. The prospects for constructing the new Panama Canal and the two-mile long Bristol Mountain trench with nuclear explosives are discussed. A brief summary of the uses of nuclear explosions for oil production, release of natural gas, isotope production and physics research is given. (F.S.)

12467 (UCRL-Trans-10197) NUCLEAR WEAPONS AND DEFENSE AGAINST THEM. Mikhailov, V.; Naumenko, I. Translated by T. Lazar for Univ. of California, Lawrence Radiation Lab., Livermore, from Nauka Zhizn, 34: No. 9, 64-74(1967). 39p. Dep. CFSTI. JCL $3.60 fs, $1.37 mf.

The history, physics, and principles of fission and fusion weapons are summarized. Formulas for protective shelters are reviewed. Methods for predicting radiation using templates, protection from light of radiation from nuclear explosions, and radiation hazards from nuclear explosions are reviewed. (F.S.)

12468 (UCRL-Trans-10200) APPLICATION OF NUCLEAR EXPLOSIONS IN THE EXTRACTION OF OIL. Kudymov, B. Ya.; Lovlya, S. A.; Lokhova, T. F. Translated by A. M. A. Mincer for Univ. of California, Lawrence Radiation Lab., Livermore, from Tr. Sess. Uch. Sov. Nar. Ispol'z. Vzryva, 5th, Frunze, Kirg. SSR, July 1963, 5: 283-5(1965). 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The possibilities of using nuclear explosions for the extraction of oil from various strata are discussed. (L.C.L.)

12469 THE INFLUENCE OF CHINESE FISSION PRODUCT AEROSOLS ON THE CONTAMINATION MEASURED IN STUTTGART-HOHENHEIM. **Wieser, Paul H.; Woerner, Fritz (Landwirtschaftliche Hochschule, Stuttgart-Hohenheim, Ger.). Pure Appl. Geophys., 66: 133-9(1967). (In German).**

The results of an investigation of the deposition of nuclear weapon debris from the third Chinese test explosion are discussed. $t^{-(1+x)}$-curves were measured and the values of the parameter x are presented. The dry and precipitation fallout samples and a hot particle were gamma-spectrometrically examined. Fractionation phenomena were studied. (auth)

12470 SEISMIC-INDUCED ARCHITECTURAL DAMAGE TO MASONRY STRUCTURES AT MERCURY, NEVADA. **Wall, John F. Jr. (Univ. of California, Livermore). Bull. Seismol. Soc. Amer., 57: 991-1007 (Oct. 1967).**

An investigation was made of selected representative buildings in Mercury, Nevada, close to many nuclear detonations within the Nevada Test Site, to determine: the validity of peak-particle velocity as a damage criteria, the peak-particle velocity which causes minor architectural damage to selected masonry structures, and the natural cracking rate for this type of structure in Nevada. Building exteriors of 41 Mercury concrete block and 2 lift-slab structures were inspected before and after detonations which gave peak-particle velocities in the range of 0.1 to 0.5 cm/sec. Only one building was older than 3 yr, and all were at distances of 33 to 78 km from the Nevada Test Site. Findings included evidence that peak-particle velocities of 0.1 to 0.3 cm/sec caused, on the average, 24 cracks in the 43 buildings, as compared to about 2.5 cracks during a similar time span of no nuclear activity. Cracks of these low levels of motion were not more severe than those occurring naturally. The Mercury experience indicated that, at that particular location, cracks occur naturally in concrete block structures at a standard or seasonal rate, and that cracking caused by ground motion from nuclear detonations would have occurred naturally in a matter of time. (BBB)

Facilities and Equipment

Refer also to abstracts 12870, 12952, 12971, 12972, 12991, 13080, 13386, 13878, 14397, and 14406.

12471 (AAEC/TM-390) FEASIBILITY DESIGN OF PRESTRESSED CONCRETE PRESSURE VESSELS FOR HIGH-PRESSURE GAS COOLED REACTORS. **Spencer, A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). May 1967. 74p. Dep.**

The design philosophy of prestressed concrete pressure vessels is examined, with particular reference to the design for a 200 MW(e) High Temperature Gas-Cooled (HTGC) Reactor. Equations for preliminary design and costing of such vessels are derived, and their use for optimization is demonstrated. Considerable design investigation in support of the methods used is presented as appendixes to the report. (auth)

12472 (BNWL-473, pp 8.1-4) ATR GAS LOOP OPERATION AND MAINTENANCE. **Last, G. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).**

Equipment, such as the ATR Gas Circulators, is in the testing stage and personnel are actively engaged in witnessing the test to determine compliance with gas loop specifications and ATR operational conditions. (auth)

12473 (BNWL-495) PLUTONIUM AIR CONCENTRATIONS AND PARTICLE SIZE RELATIONSHIPS IN HANFORD FACILITIES. **Andersen, B. V.; Nelson, I. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1967. Contract AT(45-1)-1830. 44p. Dep. CFSTI.**

Measurement results are presented from a study of a variety of potential employee exposure situations in three major plutonium handling facilities. Plutonium-239 aerosol concentration measurements ranged from near-worldwide fallout values of about one-half fCi/m^3 to several thousand fCi/m^3. The particle size distributions were found to be bimodal in nature in the majority of the samples examined. The typical aerosol showed an Activity Median Diameter (AMD) of about 0.2 μ with a geometric standard deviation of 1.4 for 60% of the ^{239}Pu, with 40% exhibiting an AMD of 2.4 μ with a geometric standard deviation of 1.3. The measured ^{239}Pu aerosol parameters were then utilized in the study of relationships of chronic inhalation with current respiratory tract models for deposition and retention of plutonium aerosols. Pulmonary burdens of ^{239}Pu for chronic exposure were calculated to be in the picocurie to nanocurie range. (auth)

12474 (BNWL-643) RADIONUCLIDE LEVELS IN AIR FILTER SAMPLES FROM THE PUREX PROCESS BUILDING. **Fager, J. E.; Brauer, F. P.; Brouns, R. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 15, 1967. Contract AT(45-1)-1830. 12p. Dep. CFSTI.**

Filtered samples of air from the Purex process building were analyzed by multiparameter gamma spectrometry to determine the concentrations of radioisotopes in the air. The methods used to sample, filter, analyze, and compute data are described. Results for the five principal fission products, ^{144}Ce, ^{137}Cs, ^{106}Ru, ^{125}Sb, and ^{95}Zr are presented as numerical data. Other isotopes found in lower concentrations are mentioned. (L.C.L.)

12475 (EURAEC-1945) STUDIES ON CYCLONES FOR STEAM SEPARATION IN BOILING-WATER REACTORS. Quarterly Report No. 7, July 1-September 30, 1967. **Vollradt (comp.) (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany). Kernenergieanlagen). Oct. 17, 1967. Contract 083-66-1TEED. 22p. (EUR-3763). Dep. CFSTI.**

Work Performed under United States-Euratom Joint Research and Development Program.

Work on the development of a steam generator consisting of a downflow cyclone designed to meet the requirements of the 600 MW(e) direct cycle boiling-water reactors now commonly used in Europe is described. Major modifications were made to the air/water test rig as a result of the considerations of the problem of

mixture distribution to cyclones in different positions in relation to the core. One of the cyclones out of two of the three concentric rows in the reactor, together with the appropriate section from the mixture plenum with the new guide plates, was simulated on the scale 1:1. The modifications were completed and a successful trial run performed. Experiments were conducted to determine the guide plate inserts which insure that all the cyclones are subjected to mixtures of the same steam quality in all operating cases. An attempt was made to improve the design of the cyclone setup. The number of cyclones which can be used was raised from 216 to 234 without the diameter of the pressure vessel of a 600 MW(e) reactor being determined by the steam separator. (auth)

12476 (ORNL-TM-1978) ENGINEERING DEVELOPMENT OF SOL-GEL PROCESSES AT THE OAK RIDGE NATIONAL LABORATORY. Haas, P. A.; Haws, C. C. Jr.; Kitts, F. G.; Ryon, A. D. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 49p. (CONF-671008-4). Dep. CFSTI.

From Symposium on Sol-Gel Processes for the Production of Ceramic Nuclear Fuels, Turin, Italy.

The development and application of equipment for sol-gel processes are described. Aqueous sols of thoria, urania, plutonia, or their mixtures are prepared by hydrothermal denitration, in precipitation-washing equipment, or in continuous solvent extraction apparatus. Sol drops are converted to gel spheres by extraction of water, or gel fragments are formed by evaporation of water. The gel particles are fired to give products of the desired densities and compositions. (auth)

12477 (RFP-1078) ASSEMBLY, WELDING, AND TESTING OPERATIONS FOR MANUFACTURE OF FUEL ELEMENTS FOR THE ZERO POWER PLUTONIUM REACTOR. Siemion, S.; Livesay, D. F. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Jan. 19, 1968. Contract AT(29-1)-1106. 10p. Dep. CFSTI.

Equipment and procedures used in cleaning, assembling, welding, and testing of stainless steel jacketed, rectangular core, fuel elements for the Zero Power Plutonium Reactor are described. (L.C.L.)

12478 (SC-RR-67-858) COMPUTER CODE HRS004: A CODE FOR THE COMPUTATION OF THE INITIAL REENTRY ANGLE AND VELOCITY OF OBJECTS DECAYING FROM EARTH ORBIT. Spahr, H. R. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. 143p. Dep. CFSTI.

Computer Code HRS004 calculates the initial reentry angle and velocity of objects decaying from circular orbits around a rotating oblate Earth using a closed form approximate solution. The variables for which the reentry angles and velocities are calculated include altitude, orbital inclination, latitude, and atmospheric model. The ballistic coefficient dependence is eliminated by presenting the product of ballistic coefficient and drag reentry angle. The six versions of this code are discussed in detail. Sample atmospheric data input and output results are presented and discussed. (auth)

12479 (UCID-15138(Rev.1)) AN AUTOMATIC, VARIABLE-VOLUME, GAS DISPENSER. Crawford, R. W. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 30, 1965. Contract W-7405-eng-48. 7p. Dep. CFSTI.

The design of an automatic, variable-volume, gas dispenser is described. This device consists of a brass or stainless steel body, two opposing air-operated valves, and a cylindrical buret whose internal volume can be varied by means of a movable "O" ring sealed piston adjusted by a micrometer head. The internal volume was calibrated against the micrometer reading. This gas dispenser is useful for the calibration of certain vacuum analytical systems where it is often desirable to inject into the system small known volumes of a standard gas. (L.C.L.)

12480 EFFECT OF GAMMA RADIATION ON REDUCTION OF IRON OXIDES BY HYDROGEN. Ansary, M. S.; Tobgy, A. N.; Ezz, S. V. Hutn. Listy, 21: 596-8(1966). (In Czech).

To develop the optimum technology for obtaining iron from Egyptian ore by reduction with hydrogen, the effect of gamma radiation on the reduction process was studied. Irradiation with gamma rays increases the rate of reduction of trivalent iron oxide, the reduction rate increasing with the dose; the effect of irradiation is shown only at low temperatures (below 400°C.); at about 600°C., the effect is no longer observed; irradiation influences the reduction mechanism only in the first phase (during conversion $Fe_2O_3 \rightarrow Fe_3O_4$). It is assumed that the irradiation method has no practical significance owing to the negligible effect of gamma radiation on reduction at the operational temperatures. (Rev. Metal. Lit.)

12481 EXPERIMENTAL STUDY OF A DEVICE TO KEEP UNIFORM THE TEMPERATURE OF A LIQUID METAL FLOWING WITH TURBULENT FLOW CONDITIONS IN A TUBE. Skupinski, E.; Tortel, J. Entropie, No. 17, 29-37(Sept.-Oct. 1967). (In French).

The efficiency and the pressure drop of several mixing devices allowing the measurement of the bulk (mixed mean) fluid temperature, at the outlet of an heated section, have been tested. All tests were carried out using a NaK loop in the 25,000 to 210,000 Reynolds number range, with constant Prandt number (1.2×10^{-2}) and heat flux (11 W/cm^2). A screw located across the flow, a series of 4 bends or a T outlet section give a quasi uniform temperature of the liquid metal stream. (auth)

12482 HEAT TRANSFER IN A STEAM BOILER WITHOUT RECIRCULATION, HEATED BY MEANS OF A LIQUID METAL. Robin, M. G.; Duchatelle, L.; de Nucheze, L. (CEA, Paris). Entropie, No. 17, 39-50(Sept.-Oct. 1967). (In French).

A 5 MW once-through liquid metal heated, double wall steam generator was operated at Grand Quevilly for 450 hr. The experimental and theoretical overall heat transfer coefficients and temperature distributions in steady state conditions for the water heating, nucleate boiling, film boiling, and steam super heating sections are reported. A fair agreement between the experimental data and the calculated values was observed. (auth)

12483 PROBLEM OF SURFACE CLEANING AND PASSIVATION FOR OBTAINING NUCLEAR GRADE CLEANLINESS. Frasch, Jean. Corros.-Trait., Prot., Finition, 15: 387-91 (Dec. 1967). (In French).

After having defined the need for cleanliness that is necessary for nuclear equipment, methods for surface cleaning and passivation for pipes in heat exchangers for the nuclear industry are suggested. (auth)

12484 ELASTIC STRESS ANALYSIS FOR THICK SHELLS OF REVOLUTION. Friedrich, C. M. (Westinghouse Electric Corp., Pittsburgh). Nucl. Eng. Design, 6: 367-75(1967).

A method of stress analysis is presented for the thick shell of revolution loaded axisymmetrically by temperature, pressure, and distributed forces. The method, based on the principle of virtual work, has been programmed for digital computers. Comparisons are made of computed results with thin shell theory and with experimental data. (auth)

12485 PRESSURE TESTS ON END SLABS FOR PRESTRESSED CONCRETE PRESSURE VESSELS. Campbell-Allen, D.; Low, E. W. E. (Univ. of Sydney). Nucl. Eng. Design, 6: 345-59(1967).

With the present trend towards cylindrical shapes in the design of prestressed concrete pressure vessels (PCPV) it may be presumed that the majority of vessels for future reactors will involve the use of deep end slabs anchored to barrel walls by axial prestressing tendons. The importance of isolating the end slabs for experimental study has been pointed out by various reports on model tests of complete vessels. The test results of a series of pressure tests on two types of slabs are summarized. The tests were designed primarily to study the influence of slab thickness and or prestress on the nature of the failure mode and on the magnitude of the ultimate pressure. Application of some of the conclusions reached to the design of end slabs for cylindrical PCPV are suggested. (auth)

12486 FUELS AND THEIR MANUFACTURE. Fuhrmann, R.; Cholin; Courcier, Ph. Atompraxis, 13: 548-50(1967). (In German).

Uranium metal fuel, oxide base fuels, and plate-type fuels used in swimming pool reactors are described. Uranium metal fabrication methods are discussed. Investigations of such fuels as ring elements, and graphite core elements are summarized. Experience gained in fabrication of fuel elements for heavy water reactors, pressurized water reactors and MASURCA is reviewed. Problems arising from the production of highly advanced plate-type fuels are briefly described. (auth)

12487 CONCENTRATION AND REFINING OF URANIUM. Renaud, J. Atompraxis, 13: 545-8(1967). (In German).

The high-grade uranium ores need, for their concentration, three main stages: mechanical conditioning necessary to obtain optimal size reduction to a possible uranium liberation; dissolution of uranium or lixiviation which is followed by washing of the tails; and selective recovery of uranium by ion exchangers or specific solvents, followed by the final conditioning of the product. The process used in French and in overseas plants is able to give, without ion exchangers or solvent, concentrates containing 25% of uranium. The uranium concentration processes lead to an impure concentrate which must be dissolved and refined to obtain a product of nuclear purity. Research is in order to simplify the circuit from the ore to the nuclear fuel and to lower the cost price. (auth)

12488 FABRICATED CONSTRUCTION IN NUCLEAR DEVELOPMENTS. Clausse, Robert. Atompraxis, 13: 530-2 (1967). (In German).

The development of large fabricated elements which form the internal items of natural uranium-graphite-gas-reactors, together with the steel parts of the reactor vessels, require frequent exhaustive scientific investigations and the use of advanced construction methods. Research carried out on the creep strength of low alloy steels under low stress and studies on plastic buckling of plates subjected to biaxial pressure are discussed. Erection methods involving the systematic pre-fabrication of all large structural parts are reviewed, and more specifically those in connection with the installation of the lower bottom of Bugey 1 vessel. (auth)

12489 EQUIPMENT FOR HOT LABORATORIES. Cazalis, J.-P. Atompraxis, 13: 560-3(1967). (In French).

Nuclear reactor plants include the usual research sections such as institutes for chemistry, physics, biology, electronics, etc. These institutes differ from the usual ones due to the necessity of radiation protection of the staff. Besides the special equipment for radiation protection such as shielding, radioactive material-handling equipment, ventilating systems, etc., laboratory facilities had to be developed for use in fields of high radioactivity. Radiation doses must be kept under control by special measurement techniques for protection of the staff. Research workers and industrial manufacturers have made great technical strides in solving these problems. (auth)

12490 NEW INSTALLATION FOR THE PRODUCTION OF UO_2 POWDER FROM UF_6. Hackstein, K. G.; Ploeger, F. (NUKEM, Wolfgang, Ger.). Atomwirt., Atomtech., 12: 524-6 (Nov. 1967). (In German).

A new plant for the manufacture of UO_2 powder from uranium hexafluoride (UF_6) is described. The process, which involves precipitation from an aqueous solution, is essentially new in that it has only a few stages and permits a direct transformation of the moist uranium precipitation products into UO_2 powder. The special characteristics of the powder made in this way enables it, without further treatment and without any additives, to be compacted with automatic lubrication of the matrices in presses specially installed for the purpose. Subsequently it may be directly sintered. The process, in addition to a considerable saving in costs, has the advantage that it is possible, with this untreated and unground powder, to manufacture not only sintered pellets with high density but also those with low density if appropriate raw materials are introduced. In addition to being used for sintered ceramic pellets the powder can by melting be converted to UO_2 of almost theoretical density which is suitable for use in vibrated fuel elements. The powder can serve as an intermediate product in the well-known conversion to UF_4 or uranium carbides. (auth)

12491 OFFICIAL STANDARDS AND INDEXES FOR MEASURING IONIZATION RADIATION. Yudin, M. F.; Karavaev, F. M.; Yaritsyna, I. A.; Ruzer, L. S. Izmer. Tekh., No. 11, 107-16(Nov. 1967). (In Russian).

Problems related to the determination of standards for measuring ionization radiation and problems of transferring the unit value from the standard to the specimens and working radiation sources and instrumentations are discussed. Methods of quantum, neutron, and β radiations dosimetry, measurements of radioactive aerosols, and neutron fluxes are analyzed. A listing of 27 references is included. (R.V.J.)

12492 ELECTROPHORETIC FILTERS WITH GRAPHITE ANODES. Kuleshova, Yu. F.; Tsykanov, V. A.; Chistyakova, G. I. At. Energ. (USSR), 23: 354-5(Oct. 1967). (In Russian).

In an electrophoretic filter with a stainless steel cathode, graphite was used as an anode replacement in place of platinized titanium. Studies were run to determine the suitability of graphite in removing iron hydroxide particles 1 to 7 μ in size under various flow conditions and temperatures. The results showed that the decontamination coefficient of reactor water from iron hydroxide on an electrophoretic filter with a graphite anode was as high as on a filter with a platinized anode. The graphite showed no deterioration at water temperatures up to 40°C and at water conductivities less than 5×10^{-5} ohm^{-1} cm^{-1}. The decontamination coefficient decreased sharply at higher temperatures and water conductivities. (TTT)

12493 ELECTRO-DISCHARGE MACHINING OF PROTOTYPE MICRONOTCH. I. Inagaki, Koji; Oishi, Yoshitame. Sci. Res. Inst., Tohoku Univ., Ser. A, 19: 109-24(July 1967).

Precision micromachining using the practical electro-discharge machine was tested. The workpieces were the Zircaloy and stainless steel tubes used for fuel element cladding. The processed tube was used in nondestructive inspection of the fuel element cladding. The notch was below 50μ in width, 3 mm and 1 mm in length and ~30 to 100 μ in depth. The precision of measurement was $\pm 1\mu$. This machining is easily done, if the electric condition can be made to fit the electro-discharge machine for the micromachining to use high precision jigs and to control the temperature and vibration is sufficient. At present the processing precision is done below $\pm$ 1μ. (auth)

12494 STORAGE POOLS: A PRACTICAL LINING PROCEDURE. Fisher, R. W.; Core, M. R.; DeJong, P. S. (Ames Lab., Iowa). Power, 111: 113(Nov. 1967).

Concrete is used in the construction of reactor storage pools. A liner of $\frac{1}{8}$ in. thick type 304 L stainless steel, bright cold-rolled to a 2B surface finish was fabricated for a storage pool. Welding procedures are described. (J.C.W.)

12495 GAS BEARING CIRCULATORS. Christian, M. (Societe Rateau, La Corneuve, France). Nucl. Eng., 12: 917-20(Dec. 1967).

The status of the development of hydrodynamic and hydrostatic gas bearing compressors is reviewed. A list of some industrial machines, with their main characteristics, is included. (UK)

12496 FIRE RESISTIVITY OF RADIOISOTOPE CONTAINERS. Jin, Tadahisa. Shobo Kenkyusho Hokoku, No. 26, 17-24 (Dec. 1965). (In Japanese).

Tests and theoretical calculations were performed for the evaluation of fire resistive performance of containers for storage of radioisotopes. A test sample of a 90 mm dia cylindrical shielded lead container was made and coated with iron on its side and bottom surfaces and heated by an electric furnace at 800°C for 30 min. Temperature rises on the surface and in the wall of the test containers were measured with a thermocouple during the test. The outermost part of lead which was in contact with the heated iron reached the melting point of lead (327°C) and began to melt in 9 min. Using the results of the test and the theory of heat conduction for various sizes of containers, the time required until the lead begins to melt and also the time it finishes melting was calculated. Results are shown in figures and tables. It was found that containers having diameter smaller than 400 mm are not absolutely safe and the larger ones are perfectly safe with the above mentioned standard heating. Radioisotopes of small quantity of not larger than 100 mC generally used for a small radiation source or tracer methods, are transported in a small bottle, paper, or vermiculite packing and sealed can. Such packages were heated at 800°C for 30 min. In this case, the paper packing was completely carbonized or burned and when the temperature of the bottle reached 800°C, the lead pot was wholly melted, but the small bottle did not melt nor crash during the tests. Leakages of radioisotopes from the packages of can-bottle type were examined after the fire-tests. At the tests, an aqueous solution of ^{24}NaCl or NH, ^{82}Br ~0.1 to 1 cc having activity of ~10 to 100 μCi had been sealed in the bottle before the tests and the cans were heated to 800°C for 30 min, in the furnace. Results are given for ^{24}Na and ^{82}Br. (NSA of Japan)

12497 DEVICE FOR CRUSHING A HIGHLY RADIOACTIVE MATERIAL. Seki, Yoshitatsu (to Mitsubishi Atomic Power Industries Inc.). Japanese Patent 1966-23977. Dec. 6, 1966. Filed Mar. 24, 1963.

A device is described for crushing a highly radioactive material such as irradiated UO_2. Using this device, the crushing can be done without contaminating the surrounding area. It consists of a solid crushing-plate (on which a material is placed) with the bottom having a number of holes; a plate (which serves as a receptacle for the particles) located directly below the first plate, with the bottom having holes of smaller diameter than those in the first plate; a casing (which can be sealed) containing the two plates; and a crushing rod (which penetrates the casing from above) for crushing the material in the first plate. The first and second plates and the rod are all in the same vertical line. (NSA of Japan)

12498 NUCLEAR FUEL COMPOSITION FOR MULTIPLICATION DETERMINATION IN REACTORS AND DRIVING SUBCRITICAL LATTICES. Robkin, M. A.; Porter, Charles R. (to United States Atomic Energy Commission). U. S. Patent 3,368,979. Feb. 13, 1968.

A method is described for improving neutron flux levels and neutron multiplication in a nuclear reactor by uniformly distributing small amounts of californium-252 throughout the fissile fuel material. (AEC)

12499 PRESSURE VESSEL DESIGN AND ANALYSIS. Bickell, M. B. London, MacMillan, 1967. 590p. 120s.

The subject is treated under the following main headings: de-

sign procedure and establishment of design requirements; selection of materials; preliminary lay-out; elastic stress analysis-general method; cylindrical shells; spherical shells; general shells of revolution; application of general analysis to more usual vessel components; stress analysis of piping systems; adequacy of design-general considerations; plastic collapse; fatigue and incremental collapse; low stress brittle fracture; creep; buckling; and special components. (UK)

12500 METHOD OF PROCESSING COATED NUCLEAR FUELS. (to Kernforschungsanlage Julich des Landes). British Patent 1,099,331. Jan. 17, 1968. Priority date June 10, 1965, Germany.

A method for processing coated fuel particles for high temperature reactors without destroying the coating in a separate process is described. The fuel is reacted at 350 to 600°C with a hyperoxide and/or peroxide melt which has been mixed with a flux. The melt consists of a mixture of one or more of the following: sodium peroxide, sodium hydroxide, potassium hyperoxide, barium peroxide, and sodium carbonate. (F.S.)

12501 DEVICE FOR MAKING CAMS FOR A MEDICAL FOCUSING-SYSTEM. Nagai, Katsumi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-2640. Feb. 16, 1967. Filed Feb. 6, 1965.

A device is described in which high precision cams fit into the lesion of the subject for irradiation. The device consists of the base plate; the first rotatable table on which the original drawing is placed; the second table, rotatable in connection with the first table, on which the cam material is placed; a lever of which one end follows the geometry of the original drawing and the other is freely movable; a working lever connected to the former lever through a movable link; and a member for drawing and cutting the cam, mounted on the working lever. The respective members are at such positions as to correspond to the arrangement of the members of an irradiation apparatus in which the "worked" cams are to be used. (NSA of Japan)

12502 DEVICE FOR INDICATING THE POSITION OF A REMOTE ELECTRICALLY OPERATED MECHANISM. Taylor, James Russell; Lewis, John Peter Leonard (to Strachan and Henshaw Ltd.). British Patent 1,100,009. Jan. 24, 1968. Filed Nov. 26, 1965.

An electrical device is described which will indicate the position of a remotely operated mechanism. The device consists of a method for superimposing an ac current of a predetermined frequency onto the dc supply for operating an electrical actuator which operates the remote mechanism. A variable impedance network in parallel with the energizing element for the electrical actuator is arranged so that an element of the network is varied according to the position of the actuator. Methods for detecting variations of impedance are provided. (F.S.)

12503 IMPROVEMENTS IN THE CONSTRUCTION OF NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Walsh, Stanley (to United Kingdom Atomic Energy Authority). British Patent 1,101,142. Jan. 31, 1968. Filed Jan. 15, 1965.

A method is described for constructing a nuclear reactor fuel assembly with a cylindrical fuel rod cluster. Sheathed fuel rods are spaced in a parallel relationship between end supports. One or more hollow members which are expansible by fluid pressure are wrapped about the sheathed fuel rods adjacent to the circumferential bracing strap position. The expansible members are connected to a source of fluid pressure which is used to expand the members and clamp the assembly centripetally. A circumferential bracing strap is then fitted in position. (F.S.)

12504 MANUFACTURE OF NUCLEAR REACTOR FUEL ELEMENTS. Smith, Harry; Stewart, Roy (to United Kingdom Atomic Energy Authority). British Patent 1,101,353. Jan. 31, 1968. Filed Apr. 7, 1964.

A clamp is described which is used to provide longitudinal compressive loading on the sheaths of a number of fuel elements arranged side by side. The overall transverse dimensions of the assembly of fuel elements and clamp being less than the overall transverse dimensions of a similar assembly of fuel elements each mounted in an individually constraining clamp. (F.S.)

12505 MANUFACTURE OF NUCLEAR REACTOR FUEL ELEMENTS. Dagg, Denys Ian (to United Kingdom Atomic Energy Authority). British Patent 1,101,354. Jan. 31, 1968. Filed Apr. 7, 1964.

A clamp is described which is used to apply torsional restraint and logitudinal compressive loading on a fuel element sheath. The sheath has heat transfer fins of long pitch. The fuel element is subjected to a process of external pressurization at elevated temperature. To keep the tube from twisting in the direction of the twist of the heat transfer fins during pressurization, the clamping members coupling with the ends of the sheath are mounted in a restraint structure extending the length of the fuel element sheath. The end clamping members are fixed in the restraint structure against rotational movement preventing twisting in the sheath. (F.S.)

12506 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGERS. Charcharos, Anthreas Nicholas (to Babcock and Wilcox Ltd.). British Patent 1,101,772. Jan. 31, 1968. Filed May 25, 1964.

A heat exchanger is described for use in reactors in which the core is cooled by the passage of liquid sodium and the heat extracted by the sodium is used to superheat steam by means of heat transfer between the sodium and the steam. The heat exchanger includes a vessel having the inlet and outlet headers incorporated in a boundary wall of the heat exchange vessel and arranged in a way as to permit a high degree of superheat and compactness with a web member in the wall located between the inlet and outlet header. The inlet and outlet members are arranged side by side. (F.S.)

12507 CONTAINER CLOSURE DEVICE. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,097,952. Jan. 3, 1968. Priority date Apr. 16, 1964, Germany.

Two closure covers for gas-tight sealing of two container openings corresponding to each other, employing sealing rings in conical grooves are described. The covers are jointly raised when the containers are tightly connected at the openings. The containers are opened by manipulators. These covers help protect hot cells from contamination when radioactive substances are used. (F.S.)

12508 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS. (to General Dynamics Corp.). British Patent 1,101,600. Jan. 31, 1968. Priority date Sept. 8, 1965, United States.

A reactor fuel element is described for use in a high temperature gas-cooled reactor for power production. The element consists of a block of refractory material having relatively good thermal conductivity and neutron moderating characterisitcs. The block has a pair of parallel flat end plates and a number of sides which are perpendicular to the end plates. The block contains a number of coolant holes extending axially through the blocks. (F.S.)

12509 CERAMIC FUEL ELEMENT FOR A GAS-COOLED NUCLEAR REACTOR INCLUDING A METALLIC FUEL CONTAINER PROVIDED WITH AN OXIDATION RESISTANT COATING. Antill, John Edward (to United Kingdom Atomic Energy Authority). U. S. Patent 3,359,176. Jan. 10, 1966. Priority date Jan. 22, 1965, Great Britain.

A fuel element is described for a gas-cooled nuclear reactor wherein the coolant is carbon dioxide. The fuel element consists of a ceramic nuclear fuel material in a non-fissile metal container. The metal is selected from the group of alloys consisting of iron-based alloys and nickel-based, iron-containing alloys, and includes a thin outer coating of an oxidation resistant material. (Offic. Gaz.)

12510 DECONTAMINATION SYSTEM FOR A CONTAMINATED CHAMBER. Valentin, Andre (to Commissariat a l'Energie Atomique). British Patent 1,102,139. Feb. 7, 1968. Priority date July 8, 1965, France.

A decontamination system is described which is used in a facility consisting of a number of hot cells used for cutting and milling materials with a high level of radioactivity such as Pu. The cells consist of detachable sealed α-tight protective chambers disposed in β and γ protective chambers. The α chamber is a work plate closed by a detachable bell connected with the plate by a suitable gasket. Lifting means for the α chamber are provided. A traveling crane removes the α chamber to the decontamination chamber, and a second crane removes the bell. In the decontamination chamber methods are provided for extracting contaminated air. After decontamination and reassembly, the α chamber is returned to the β or γ protective chamber. (F.S.)

12511 IMPROVEMENTS IN OR RELATING TO METAL-LINED CONCRETE PRESSURE VESSELS. Brown, Brian David (to Atomic Power Constructions Ltd.). British Patent 1,101,067. Jan. 31, 1968. Filed Nov. 30, 1966.

A metal-lined concrete pressure vessel having a method for circulating a fluid between the lining and the pressure vessel is described. A flexible fluid-tight seal is provided between the method for circulating the fluid and the metal lining. The pressure vessel is used with gas-cooled reactors. (F.S.)

12512 POSITION INDICATING DEVICES. Pettinger, Donald Stanley; Duncombe, Edward; Harrison, Edwin (to United

Kingdom Atomic Energy Authority). British Patent 1,101,058. Jan. 31, 1968. Filed May 14, 1964.

A position indicating device of the variable inductance type is described. The device has a winding in the form of a coil of metallically sheathed electrical conductor cable having a conductive core which is insulated from the sheathing by refractory electrical insulating materials. The position indicator may be used in the detection of control rod positions in marine reactors, especially pressurized water reactors. (F.S.)

12513 FUEL ELEMENT FOR A WATER-COOLED NUCLEAR REACTOR. Mogard, Johan Hilding (to Aktiebolaget Atomenergi). British Patent 1,101,958. Feb. 7, 1968. Priority date July 22, 1964, Sweden.

A fuel element for a water-cooled reactor utilizing a metallic fuel is described. The fuel element consists of metallic U, U alloys, Pu, or Th which is enclosed in a Zr or stainless steel can. An intermediate can consisting of Al or Mg or their alloys is employed. The intermediate can contains holes or canals in its outer wall which extend longitudinally through the entire height of the walls. These holes or canals allow fuel metal expansion. There should be a snug fit between the fuel and the intermediate can, and the intermediate can and the outside can for good heat transfer. (F.S.)

12514 IMPROVEMENTS IN OR RELATING TO ROD, PIN, AND TUBE ASSEMBLIES. Charcharos, Anthreas Nicholas (to Babcock and Wilcox Co., Ltd.). British Patent 1,101,953. Feb. 7, 1968. Filed Oct. 20, 1964.

A method for supporting an array of rigid elongated members such as pins, rods, or tubes is described. The support device is concerned with positioning the members relative to each other in the array and consists of strips extending transversely of the members with the strips arranged in two groups. Strips of one group are placed transversely in relation to the strip of the other group. Each elongated member is engaged by one strip of each group at different locations on the member. The strips are curved so that they make surface engaging contact with the member. (F.S.)

12515 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENT CANNING PROCESSES. Bailly, Henri; Ringot, Claude (to Commissariat a l'Energie Atomique). British Patent 1,102,195. Feb. 7, 1968. Priority date July 9, 1964, France.

Improvement in pressure canning processes used in producing reactor fuel elements is described. In reactor fuels which consist of pellets enclosed in a can, the can is put in a rigid outer casing with an ID slightly greater than the OD of the can. The outer can has the same shape as the inner can. Pressure is applied during canning to prevent bending. (F.S.)

12516 FUEL ELEMENT FOR NUCLEAR SUPERHEAT REACTOR. (to Hitachi Ltd.). British Patent 1,102,137. Feb. 7, 1968. Priority date May 24, 1965, Japan.

A fuel element is described which is used in a superheat reactor. The fuel element consists of fuel material and a process tube surrounding and spaced from the fuel material to provide a coolant passage. The process tube is made of fertile material and/or a burnable poison whose fissile material content is lower than that of fuel material. The process tube provides thermal insulation between coolant passing through the passage and the moderator. (F.S.)

12517 HIGH-PRESSURE SEALING SYSTEM. Cogez, Paul; Conte, Madelaine; Sabatier, Jacques (to Commissariat a l'Energie Atomique). British Patent 1,101,930. Feb. 7, 1968. Priority date Oct. 15, 1965, France.

A sealing system used for vessels containing fluid at very high pressure is described. The sealing system is used for a stationary component which traverses the wall of a vessel or as a dynamic seal for a moving component which traverses the wall and either slides or rotates. Leak-tightness is ensured even when the pressure of the internal fluid is high. (F.S.)

12518 DEVICE FOR POLISHING SPECIMENS. Klein, Jacques; Mansard, Bernard (to Commissariat a l'Energie Atomique). British Patent 1,102,738. Feb. 7, 1968. Priority date Feb. 18, 1966, France.

A device is described which is used to polish the end surfaces of specimens of cylindrical shape in hot laboratories. The device consists of a rotary polishing disc having a flat abrasive face at right angles to its axis of rotation and a mechanism for retaining and driving specimens in rotation. This mechanism consists of at least one roller mounted on a spindle parallel to the drive shaft of the polishing disc. A wheel is mounted on a spindle parallel to the drive shaft of the polishing disc. The wheel is driven by a cone coupled to the disc. The position of the roller and the wheel is such that friction between the disc and the specimen pushes the specimen against the roller and the wheel. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 12475, 12481–12483, 12506, 12533, 12554, 12555, 12975, and 14365.

12519 (EUR-3658) WAERMEUEBERGANG AN WASSER BEI ERZWUNGENER STROEMUNG IM DRUCKBEREICH VON 140 BIS 250 BAR. DARSTELLUNG DER VERSUCHSERGEBNISSE. (Heat Transfer in Water With Forced Circulation in the 140 to 250 Bar Pressure Range. Results of Investigations). Herkenrath, H.; Moerk-Moerkenstein, P.; Jung, U.; Weckermann, F.-J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Dec. 1967. 132p. (In German). Dep.

The performance of nuclear reactors is significantly influenced by the critical heat flux density. In the pressure range of more than 170 bar, reactors may be operated near or even beyond the critical heat flux density without danger to the fuel elements. It is therefore important to investigate the heat transfer in the regions of the various heat transfer crisis and to know the maximum wall temperatures. Forced convection heat transfer conditions at pressures between 140 and 250 bar were measured at different heat flux and mass flow densities. The results of these investigations, obtained in vertically arranged test sections (circular tubes of 10 and 20 mm ID) with special regard to the wall temperature under the indicated test conditions, are presented. (auth)

12520 (K-1732) NUMERICAL INVESTIGATION OF A CONFINED VORTEX PROBLEM. Textor, Robin E. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). Jan. 26, 1968. 52p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

In terms of cylindrical coordinates, the Navier–Stokes equations and the equation of continuity are derived for axisymmetric, imcompressible flows wherein the pressure is the only important external force. A problem is described in which a cylinder containing fluid and a coaxial tube are in rotation with one of the cylinder end walls at a constant angular velocity, the other cylinder end wall remaining stationary. A successive overrelaxation iterative procedure is described whereby the system of partial differential equations involving the classical stream function and vorticity are solved at steady-state. Some observations of the solutions thus obtained are made for tangential Reynolds numbers from 1 to 2000. Four other methods are discussed by which solutions of the problem either have been or may be attempted. (auth)

12521 (ANL-Trans-557) FLOW OF RADIATING HYDROGEN IN AXIALLY SYMMETRICAL NOZZLES. Aleksandrov, V. V. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 4, 19-28(1967). 17p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

A method for the numerical calculation of a two-dimensional equilibrium flow of a nonviscous nonheat-conducting radiating gas with a variable absorption coefficient, such as radiating absorbing hydrogen in axially symmetrical nozzles is presented. It was assumed that the radiation is in local thermodynamic equilibrium; the flux of the radiation energy through the wall is equal to zero; the nozzles possess semiinfinite cylindrical entry parts; and initial gas flow is supersonic. The field of radiation density and flow parameters within the nozzle were calculated. (F.S.)

12522 DETERMINATION OF THE CONVECTION COEFFICIENT OF A NaK ALLOY FLOWING COUNTERCURRENTLY IN A SINGLE TUBE EXCHANGER. Duchatelle, L.; de Nucheze, L. (Centre d'Etudes Nucleaires, Saclay, France). Entropie, No. 17, 51-8(Sept.-Oct. 1967). (In French).

Using a countercurrent annular NaK heat exchanger (inner nickel tube: 30 mm OD 2.5 mm wall dia, outer austenitic steel tube; 60 mm OD 2 mm wall dia), the liquid metal heat transfer in tube and annulus, in the 60 to 1,600 Peclet number range, was studied. Experimental data are reported and compared to previous results. (auth)

12523 SURFACE THERMOELASTIC STRESS FOR POLYGONAL CYLINDRICAL HEAT-PRODUCING BODIES. Scott-Rogers, L. R. (Univ. of New South Wales, Kensington). Nucl. Eng. Design, 6: 376-82(1967).

An infinite series method is developed for the numerical solution of the thermoelestic stress field in a simply connected isotropic body having constant power density. The method is applied to a polygonal cylindrical body and the surface thermoelastic stress is analyzed using an IBM 7040 computer. Conclusions are drawn

regarding the magnitude of the stress factors obtained and the results are compared with those obtained by other methods. (auth)

12524 LAMINAR FLOW HEAT TRANSFER FROM AN ARGON PLASMA IN A CIRCULAR TUBE. Incropera, F. P.; Leppert, G. (Stanford Univ., Calif.). Int. J. Heat Mass Transfer, 10: 1861-73(Dec. 1967).

The laminar flow of a plasma in the entrance region of a circular tube was analyzed using an implicit finite-difference scheme. The solution is based upon the boundary-layer equations with the plasma radiation term retained in the energy equation, and the transverse convection term retained in both the momentum and energy equations. Numerical results were obtained for an argon plasma having a linear enthalpy and cubic velocity profile at the tube entrance. At the low temperature limit of the analysis, the friction factor is in agreement with previously published results; and in all but a very small region near the tube entrance the local Nusselt number agrees with the Nusselt number for constant property, fully developed flow to within approximately 17 per cent. (auth)

12525 EFFECT OF PROPERTY VARIATION ON THE TURBULENT FLOW OF GASES IN TUBES: THE THERMAL ENTRY. Magee, P. M. (Atomics International, Canoga Park, Calif.); McEligot, D. M. Nucl. Sci. Eng., 31: 337-59(1968).

Results of a new semiempirical analysis for heat transfer and new data for wall friction for turbulent gas flow in the thermal entrance region of circular tubes under conditions where the fluid properties vary are discussed. Application of numerical techniques for solution of partial-differential equations yielded partial improvement over the integral energy equation solution, utilizing the same velocity profile. The discrepancy between experiment and analysis increases as the heating rate is raised. It appears that additional fundamental knowledge or concepts must be introduced to handle the problem in detail. No analyses to predict the effect of property variation on wall friction behavior in the thermal entry region are currently available, but an empirical equation which is given should be useful for design purposes. (auth)

12526 HEAT TRANSFER TO NaK FLOWING THROUGH UNBAFFLED ROD BUNDLES. Kalish, Sheldon; Dwyer, Orrington E. (Brookhaven National Lab., Upton, N. Y.). Int. J. Heat Mass Transfer, 10: 1533-58(Nov. 1967).

In-line flow results are reported on nine different test rods located in the center of a 19-rod bundle. The results on the first five test rods were in fairly good agreement with theoretical predictions and with earlier results obtained on mercury, but those on the last four fell low in the molecular-conduction (low Peclet number) regime. It was concluded that the difficulty was due to less-than-perfect wetting of the heating surface, coupled with the presence of inert seal gas at the heating surface. Results were also obtained for 90° and 45° cross flows through rod bundles with only the test rod heated and with all rods heated. Semi-empirical equations are proposed for predicting heat transfer coefficients for cross flows on the basis of the results, with support from previous experimental and theoretical results. (auth) (UK)

12527 HEAT TRANSFER AND PRESSURE DROP MEASUREMENTS IN CHANNELS WITH WHITWORTH THREAD FORM ROUGHNESS. Furber, B. N.; Cox, D. N. (Nuclear Power Group, Ltd., Knutsford, Eng.). J. Mech. Eng. Sci., 9: 339-50 (Dec. 1967).

The heat transfer and pressure drop performance of three 4-in. nominal bore tubes internally roughened with Witworth thread forms of 11, 24, and 60 threads per inch (t.p.i.) was measured with the tubes empty and with a concentrically mounted smooth cylinder of 2.012 in. dia. The tube with the 24 t.p.i. roughness form was also tested with a concentric cylinder of 2.00 in. dia having the same geometric roughness. The measured Stanton number and friction factors of the annuli with the smooth inner walls were transformed, using a method suggested by Hall, and compared with the empty channel and completely roughened annulus data. (auth) (UK)

12528 CONTRIBUTION TO THE STUDY OF HEAT TRANSFER IN TURBULENT FLOW IN A SMOOTH TUBE: APPLICATION TO LIQUID METALS. Taccoen, Lionel (Electricite de France, Chatou). Int. J. Heat Mass Transfer, 10: 1649-60(Dec. 1967). (In French).

For air and water in simple geometries the equations $\overline{T}^+ = f(y^+, Pr)$ and $u^+ = g(y^+)$ enable direct calculation of the heat transfer coefficients. It is shown that the hypotheses are equally valid in the case of liquid metals and, in general, for liquids of $Pr \ll 1$. The method gives results in good agreement with experiment, and differences are accounted for by the thermal contact resistance. (UK)

12529 ANALYTICAL STUDY OF HEAT TRANSFER TO LIQUID METALS FLOWING ALONG A ROW OF SPHERES. Hsu, Chia-Jung (Brookhaven National Lab., Upton, N. Y.). Int. J. Heat Mass Transfer, 10: 1693-1708(Dec. 1967).

On the postulation of inviscid potential flow, theoretical analyses were performed for heat transfer to liquid metals flowing along a row of equally-spaced spheres, the pitch-to-diameter ratio of which ranged from unity (touching spheres) to infinity (a single sphere in the fluid stream). The following explicit expressions for the average Nusselt number were obtained: for uniform surface temperature: $\overline{Nu} = (2/\pi)^{1/2} Pe^{1/2} (\phi_s'/R^3)^{1/2}$, and for uniform surface heat flux: $\overline{Nu}_D = 1.0035\ Pe^{1/2} (\phi_s'/R^3)^{1/2}$. It was revealed that the surface velocity potential factor, ϕ_s'/R^3, is solely a function of the pitch-to-diameter ratio. A theoretical method was developed for evaluating the numerical values of ϕ_s'/R^3 utilizing the vector potential recently obtained by Michael. In connection with this, an equation describing the velocity potential along a row of spheres was obtained. Numerical values of ϕ_s'/R^3 were determined by means of an IBM digital computer. It was found to vary from 2.0 for flow past a single sphere to ≈1.5639 for flow along a row of touching spheres. (auth)

12530 UNCONVENTIONAL APPLICATIONS OF TWO-PHASE COCURRENT FLOW. Silvestri, M. (CISE, Milan). Energ. Nucl. (Milan), 15: 14-23(Jan. 1968).

A survey is reported of unconventional applications of two-phase cocurrent flow, e.g., cooling of nuclear (thermal) reactors and those related to problems in chemical engineering. There are other cases in which cocurrent two-phase flow could be applied in competition with existing processes of a different nature. Among such unconventional applications are the following: magnetohydrodynamic conversion of heat into electricity by means of liquid metals; two-phase flow heat exchangers, in which both streams are operated in cocurrent flow of a noncondensable gas, a vapor and its liquid; high pressure, high temperature electrolytic cells for production of hydrogen to be converted into ammonia; countercurrent distillation plants based on cocurrent mass transfer; multiflash distillation units for water desalination; refrigerating units based on absorption processes; two-phase flow control rods for fast control of thermal reactors; prompt reactivity control of D_2O moderated reactors; cooling of fast breeder reactors with medium pressure two-phase flow steam water mixtures; and long term reactivity control of spectral shift reactors. (auth)

12531 STUDIES OF BURNOUT IN BOILING HEAT TRANSFER. Bennett, A. W.; Hewitt, G. F.; Kearsey, H. A.; Keeys, R. K. F.; Pulling, D. J. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Inst. Chem. Eng. (London), 45: T319-33 (1967).

Studies were made of the effect of a "cold patch" or unheated length in various positions along a tube in which burnout heat flux was determined. Experiments of this sort, done at both low and high pressures can be interpreted to give information about the behavior of the liquid phase in the channel. This interpretation was aided by making direct measurements of liquid film flow-rate for the low pressure case. It was found that, with the cold patch in certain positions, the power required for burnout could actually be higher than that for a uniform tube of the same total length. The interpretation of the cold patch data suggested that other arrangements of heat flux distribution could give similarly higher powers. Experiments are described on burnout in tubes with a peak in heat flux at the entrance and, as expected, these results show an improvement in burnout power over wide ranges of conditions. In some tests, burnout did not occur at the end of the heated test section and these results could be interpreted to give the rate of deposition of entrained droplets which, in turn, led to a calculation of mass transfer coefficient for droplet to wall transfer. Values were also calculated from previous non-uniform and mixed inlet data; it was found that the mass transfer coefficient was a function of liquid concentration and mass velocity. The data were used to calculate minimum (i.e. deposition controlled) heat fluxes for burnout as a function of local quality. Comparison of the condition for deposition control with the condition for burnout in uniformly heated tubes led to an interpretation of burnout in terms of four zones. (auth)

12532 SOME DEDUCTIONS FROM BOWEN'S NON-NEWTONIAN TURBULENT CORRELATION. Harris, J. (Queen's Coll., Dundee, Scotland). J. Mech. Eng. Sci., 9: 414-16(Dec. 1967).

Starting from Bowen's empirical correlation for non-Newtonian turbulent flow through pipes, deductions are made about the form of the velocity profile, the effective viscosity, the Reynolds number for dynamic similarity and the associated form of the friction factor–Reynolds number correlation. (auth) (UK)

Isotope Technology

Refer also to abstracts 12478, 12557, and 12692.

12533 (ALO–3633-5) DEVELOPMENT OF 400–1800°F FIBROUS-TYPE INSULATION FOR RADIOISOTOPE POWER SYSTEMS: MICROTHERM 20 Cr. Collins, J. O. (Johns-Manville Research and Engineering Center, Manville, N. J.). June 9, 1967. Contract AT(30-1)-3633. 15p. Dep. CFSTI.

MICROTHERM 20 Cr was evaluated as a potential thermal insulation for use in radioisotope thermoelectric generators. Due to the similarity between this material and the Johns-Manville family of MIN-K products, Johns-Manville assembled the data on MICROTHERM. The thermal efficiency of MICROTHERM 20 Cr appears to be as good as MIN-K. The other properties are poorer than MIN-K. MICROTHERM will not be considered further for use in radioisotope thermoelectric generators. (auth)

12534 (BNL–50084) GAMMA RAYS FOR FUN AND PROFIT. Brookhaven Lecture Series Number 56. Manowitz, Bernard (Brookhaven National Lab., Upton, N. Y.). Apr. 20, 1966. 13p. Dep. CFSTI.

The history of programs to find uses for fission products is reviewed briefly. The gamma emitting radioisotopes, ^{60}Co and ^{137}Cs, are described in detail as to characteristics, availability, and the design of irradiators using these sources. The results of specific applications of gamma radiation to insect control, food preservation, and polymerization studies are presented. (L.C.L.)

12535 (SC-CR–67-2792) DOSE PREDICTIONS AND BIOLOGICAL CONSEQUENCES FOLLOWING BURNUP OF A $^{90}SrTiO_3$ SOURCE IN SPACE. Clark, T. G. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract ASB 48-5377. 21p. Dep. CFSTI. For Sandia Corp., Albuquerque, N. Mex.

The radiological hazard to the general population from the possible release of ^{90}Sr isotopic fuel in space is studied. Risk estimates are based upon the induction of leukemia and bone cancer in man. (auth)

12536 (WANL–3800-4) QUARTERLY PROGRESS REPORT [ON SNAP-23A PROJECT, PHASE I], JUNE 1–AUGUST 31, 1967. Cerni, S. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Contract AT(30-1)-3800. 175p. (WANL-PR(SS)–007). Dep. CFSTI.

A design analysis was completed for replacing the lead-acid power supply in the Navy Acre Buoy with a SNAP-23A power supply. The buoy is used to provide upper water level temperature, pressure data, and surface weather information for the Anti-Submarine Warfare Environmental Prediction System (ASWEPS) for remote locations. Procurement of all major hardware for the Experimental Mockup System was initiated. Some delay was experienced in the delivery of this hardware. The radiator thermal test was scheduled. Delivery of the Experimental Mockup Converter, after acceptance testing and 500 hours of seasoning, is expected. A schedule for the Prototype Mockup Converter was developed. The preliminary thermal definition will be based on the above radiator and converter tests along with results from bell jar and 10 couple tests. Final thermal definition will result from data obtained in the Experimental Mockup System test. On this basis, delivery of the Prototype Mockup Converter is expected in mid-April, 1968. Evaluation of the 100, 500, and 1,000 hour materials compatibility tests was completed. A problem with the use of titanium as the diffusion barrier material between the capsule and shield was identified. At 1400°F, it appears that nickel diffusion in titanium is very rapid, circumventing the function of the barrier. Initial tests up to 1800°F using both tantalum and tungsten as substitutes for titanium have indicated no problem with either of these materials. Based on these results, tantalum is being recommended as the diffusion barrier material. (auth)

12537 (AEC-tr–6723) RADIOACTIVE ISOTOPES IN MINING AND ORE BENEFICIATION. Rudanovskii, A. A. Translation of Radioaktivnye Izotopy v Gornom Dele i Obogashchenii Poleznykh Iskopaemykh, Atomizdat, Moscow, 1965. 157p. (IPST-Cat.–1905). CFSTI. JCL $12.00 fs, $5.15 mf.

The uses and prospective uses of radioisotopes in mining and mineral dressing are summarized. The mechanical miner is controlled and guided by a radioisotopic device consisting of a source and detector system which determines the mineral interface. The following sources are considered for this application: ^{60}Co, ^{137}Cs, ^{75}Se, and ^{65}Zn. Blasting efficiency may be increased by using ^{60}Co in spacing blast holes. Radioisotopes are used in filling mine and train cars, detecting foreign materials in bins, testing conveyor strength, and controlling slurry density in hydraulic transport. Safety conditions can be improved by using isotopes for detecting and measuring methane gas, thickness of deposited dusts, fire alarms, air ionization, and for production of lights and luminous emergency warnings. Tracers used in mining are also discussed. (F.S.)

12538 (MLM–1471(tr)) THERMAL DIFFUSION IN KRYPTON. THE EFFECT OF TEMPERATURE ON THE SEPARATION CONSTANTS. Casas, J.; Saviron, J. M.; Gonzalez, D.; Quintanilla, M. Translated for Mound Lab., Miamisburg, Ohio, from An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 60: 153-8(1964). 13p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Temperature influence on optimum pressure and maximum separation factor at the steady state for Kr was studied with the aid of a thermal diffusion column. Good qualitative agreement was found between experimental results and theoretical predictions from both potential and (12, 6) Lennard–Jones models. (auth)

12539 (MLM–1473(tr)) SEPARATION OF ISOTOPES IN THE TEMPERATURE RANGE IN WHICH DISSOCIATION PROCESSES OCCUR. Frie, W. Translated for Mound Lab., Miamisburg, Ohio, from Z. Phys., 185: 493-506(1965). 24p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

This paper was abstracted from the original language and appeared in NSA as 19: 30636. (M.C.G.)

12540 (MLM–1476(tr)) THERMAL DIFFUSION IN BINARY SYSTEMS OF THE ISOTOPES OF NEON, METHANE, AND THEIR MIXTURES. Quintanilla, M. Translated for Mound Lab., Miamisburg, Ohio, from Rev. Acad. Cienc. Exactas, Fis.-Quim. Natur. Zaragoza, 18: 89-143(1962). 64p. Dep. CFSTI. JCL $6.60 fs, $2.12 mf.

The possibility of determining thermal diffusion coefficients by means of the Clusius–Dickel column was confirmed. The characteristic behavior of isotopic–isobaric $^{13}CH_4$, $^{12}CH_3O$ molecules during thermal diffusion was determined in systems with ^{20}Ne and ^{22}Ne. An effect of molecular size on thermal diffusion was observed. The effective separation of methane molecules with ^{13}C and ^{12}C in a thermal diffusion column increased when neon was added. Results confirmed the prediction that the thermal diffusion coefficient for isotopic mixtures is independent of the concentration. A value of 0.003 was found for the thermal diffusion coefficient in the system $^{12}CH_4$–$^{13}CH_3O$. Results of the binary systems of isotopic methane molecules can be interpreted better if the term giving the relation of the thermal diffusion coefficient to the mass is supplemented by a term proportional to the relative difference of the moments of inertia. (M.C.G.)

12541 (MLM–1477(tr)) THERMAL DIFFUSION IN MULTICOMPONENT MIXTURES. Saviron, J. M.; Gonzalez, D. Translated for Mound Lab., Miamisburg, Ohio, from Rev. Acad. Cienc. Exactas, Fis.-Quim. Nature. Zaragoza, 20: 203-52(1965). 49p. Dep. CFSTI. JCL $4.60 fs, $1.67 mf.

The relation given by theory between the separation factor and pressure in a Clusius–Dickel column was confirmed experimentally for the multicomponent isotopic mixture of Kr. The form factors obtained according to the potential model and the Lennard–Jones model give qualitatively consistent predictions for the dependence of the optimum pressure and the maximum separation factor on the temperature. Both vary analogously for both models, since this relationship is particularly in accord with the optimum pressure. The variation of the optimum separation pressure with the wire temperature, determined experimentally for the case of Kr, coincided with that predicted by the theory of the potential model, when a viscosity index different from that given in the literature is adopted for this range of temperatures. The behavior of the column at any other wire temperature may be predicted on the basis of data obtained for a column at a given temperature. Moreover, the data obtained in a column can be utilized for the design of other columns with different geometries and temperatures, but always on the basis of some analogous construction characteristics as those found in the case of Kr. A graphic method is presented for the design of a hot-wire column, the optimum pressure of which has a pre-established value. A calculation method on an IBM 1620 computer was developed, which permits a determination of the isotopic distributions along a column. This method was proved experimentally in a column designed and constructed for this purpose; the theoretical and experimental values are in agreement within the range of the mean error. A theoretical study was made of the separation conditions of ^{84}Kr as a function of the column length. A minimum equivalent length of 22.02 was obtained for complete separation of the cited isotope in a closed installation and in a single operation. The IBM 1620 computer was utilized to obtain a method of successive recharging for the enrichment of the ^{84}Kr isotope. Two successive operations permit the complete separation of this isotope with the use of a column length of only 14.941. (auth)

12542 (MLM-1478(tr)) ON THE THEORY OF ISOTOPE SEPARATION BY THERMAL DIFFUSION. Casas, J.; Saviron, J. M. Translated for Mound Lab., Miamisburg, Ohio, from Rev. Acad. Cienc. Exactas, Fis.-Quim. Natur. Zaragoza, 16: 117-51(1961). 44p. Dep. CFSTI. JCL $4.60 fs, $1.52 mf.

Transport coefficients for thermal diffusion columns were obtained and are adequate for the case of gases with a viscosity index n = ½. A differential equation was solved to permit a calculation of the form factors. Analytical expressions are given for the form factors k_c' and k_d' due to convection and ordinary diffusion, respectively. For the factor h' corresponding to the thermal diffusion transport, a dependence on the temperature °C T^b was selected. All of the earlier results were expressed in the form of multiplicative corrections for the transport terms given by Jones and Furry for the plane case and for Maxwellian interaction. The first term of the expansion takes the new interaction model into account, while the second considers the cylindrical shape of the column. Comparative tables are given of the results obtained for the form factors and those for the case of n = 1. A comparative study of the optimum separation pressures in the two limit cases is made by tabulating the combination of form factors in the two cases, showing that for the temperature ranges of the table, the deviations from the case n = ½ are smaller than those assumed by Jones. The greatest discrepancy between the two cases is about 1.6%. Three comparisons of the theory with experimental data were made. The agreement was generally satisfactory. (auth)

12543 (MLM-1479(tr)) THE SEPARATION TUBE. XII. PURIFICATION OF THE LIGHT ARGON ISOTOPE ^{36}Ar AND CONCENTRATION OF THE ARGON ISOTOPE ^{38}Ar UP TO 90 PERCENT THROUGH USE OF AUXILIARY GASES. Clusius, Klaus; Schumacher, Ernst. Translated for Mound Lab., Miamisburg, Ohio, from Helv. Chim. Acta, 36: 969-84(1953). 37p. Dep. CFSTI. JCL $3.60 fs, $1.31 mf.

Natural argon contains 0.337% ^{36}Ar and 0.063% ^{38}Ar along with ^{40}Ar. Both light isotopes were concentrated to a high degree in a separation tube with hydrogen chloride used as an auxiliary gas. The characteristic stabilization time of a continuous separation decreased to ⅓ of its original value through use of an auxiliary gas. In the presence of an auxiliary gas an amount of ^{36}Ar five times smaller than the original amount was sufficient for the production of a concentration process necessary for the continuous separation in the installation. Thus it is possible to obtain from a given supply more of the desired isotopes in purified form than would be possible without the auxiliary gas. The ^{38}Ar isotope, of which only 1 cm^3 was available, was brought to 90% purity by "encircling" between $D^{35}Cl$ and $D^{37}Cl$, corresponding to a separation factor of 14300. This concentration made possible an investigation of its hyperfine structure. As a disadvantage, the increase in the characteristic separation length for the $^{36}Ar/^{40}Ar$ separation caused by the auxiliary gas must be considered. (auth)

12544 (UCRL-Trans-10181) RADIOLUMINESCENCE OBTAINED WITH β RADIATION FROM ^{147}Pm. CONSTRUCTION OF LUMINOUS SOURCES. Serra, M. Translated by W. Gillam for Univ. of California, Lawrence Radiation Lab., Livermore, from Ric. Sci., 36: 662-4(1966). 9p. Dep. CFSTI. JCL $1.10 fs, 10.80 mf.

A series of sources were constructed to obtain fluxes and radiances sufficiently high for applications in lighting technology. Promethium-147, with a half life of 2.5 years, in the chemical form $PmCl_3$ was used as the β source. The fluorescent salt used was a solid solution of Zn and Cd sulfides activated with Cu. The apparatus used in the construction of the luminous source is described. (F.S.)

12545 PRESENT STATE OF INDUSTRIAL USE OF RADIOISOTOPES IN FRANCE. Leroy-Beaulieu, H. Atompraxis, 13: 555-6; 559-60(1967). (In German).

A survey is given of the different public and private organizations concerned with the development and the research of radioisotope uses in France. The activities of private companies in the various fields of radioisotope use in industry are described. The part that the specialized ATEN working group plays in the promotion of industrial use of radioisotopes in France is considered. (auth)

12546 THE USE OF RADIOISOTOPES AND RADIATION IN USSR, GREAT BRITAIN, FRANCE, AND CZECHOSLOVAKIA. Lolic, B. M. (Boric Kidric Inst. of Nuclear Sciences, Belgrade). Isotopenpraxis 3: 425-31(1967).

A survey of radioisotope applications in four European countries is given. The survey is based on the detailed report prepared by the group of 15 experts during their 70-day study tour organized by the International Atomic Energy Agency in Vienna, at the end of 1966. The purpose of the tour was the acquaintance with the application of radioisotopes and radiation in industry and research. Organization of industrial radioisotope work and basic forms of radioisotope applications are described. (auth)

12547 THERMOELECTRIC GENERATORS USING RADIOISOTOPES. Albany, H. J. (Centre d'Etudes Nucleaires, Saclay, France). Entropie, No. 17, 79-83(Sept.-Oct. 1967). (In French).

The use of radioisotopes as auxiliary sources of energy is expected to increase considerably; among the methods of conversion of heat into electricity, thermoelectricity is at present one of the most used from these sources. Phenomena on which are based thermoelectric conversion of energy are briefly outlined, and factors determining generator performance are examined. Selection criteria of radioisotopes are given, with a reminder of the characteristics of some of these compounds. The possibilities of using thermoelectric isotopic converters as power generators in spatial, terrestrial, oceanographic, medical and other fields are underlined. Finally, the development and achievements of these generators within the last few years are reviewed. (auth)

12548 THE THEORY OF A REAL ISOTOPE ENRICHING CASCADE. I. Apelblat, A.; Ilamed-Lehrer, Y. (Israel Atomic Energy Commission, Tel-Aviv). J. Nucl. Energy, 22: 1-14(Jan. 1968).

The theory of a real (mixing) cascade operating with constant cut number and without losses was developed. The steady-state distribution of the isotope concentrations in every stage, the value function, the form factor, the equilibrium time, and the number of stages for a desired enriched product in the low concentration range were calculated. The results of the calculations for this real cascade were compared with the corresponding results for the ideal cascade. In the design of a real cascade the concept of a 'quasi-ideal' cascade, corresponding to the ideal cascade, was introduced. (auth) (UK)

12549 THE THEORY OF A REAL ISOTOPE ENRICHING CASCADE. II. Apelblat, A.; Ilamed-Lehrer, Y. (Israel Atomic Energy Commission, Tel-Aviv). J. Nucl. Energy, 22: 15-26(Jan. 1968).

The theory of a real (mixing) cascade working with constant cut number and with losses was developed. The steady-state distribution of the isotope concentrations in every stage, the total flow rate, the form factor, and the number of stages for a desired final enrichment in the low concentration range were calculated. The results obtained were compared with those for the ideal (no mixing) cascade working with losses. The dynamic behaviour on the cascade was considered. A method for computing the distribution of concentrations in an arbitrary range is proposed. The thermodynamic efficiency of the separating element was determined. (auth) (UK)

12550 EXPERIMENTAL VERIFICATION OF THE THEORY OF THE THERMAL-DIFFUSION COLUMN. Rutherford, W. M.; Kaminski, K. J. (Mound Lab., Miamisburg, Ohio). J. Chem. Phys., 47: 5427-32(Dec. 15, 1967).

The accuracy of the Jones and Furry theory of the thermal-diffusion column was tested in an extensive series of $^{20}Ne-^{22}Ne$ separation experiments. The experiments covered a range of cold-wall to hot-wall radius ratios from 2.95 to 20 and a range of hot-wall temperatures from 108 to 815°C. Measured column transport coefficients were compared to theoretical values based on the measured transport properties of neon. The average ratio of the experimentally determined initial transport coefficient to the value calculated from theory was 0.899 ± 0.047; the similar average ratio for the convective remixing coefficient was 1.18 ± 0.129; and the average ratio for the diffusive remixing coefficient was 0.963 ± 0.056. (auth)

12551 RADIOGRAPHY WITH ^{192}Ir γ RAYS. Maruyama, Yutaka. Hihaki Kensa, 15: 266-70(July 1966). (In Japanese).

The ^{192}Ir source is a 2 mmφ × 2 mm cylinder and its intensity 7.7 Ci. This source is placed in an outer capsule. Its radiation intensity can be measured by x-ray transmission photography. Exposure charts were made for film. The apparatus measuring transparency (transmission) depends on the film contrast and the energy intensity. Consequently, it is necessary to keep constant the size and intensity of the source. The half-value layers of steel and Al for ^{192}Ir were obtained. Its effective intensity is approximately 400 kV. If the working time with ^{192}Ir is to be less than 5 minutes (similar to the x-ray procedure), several tens of curies will be required. For 2% identification, ^{192}Ir is not suitable for measuring a sample at a depth below 15 mm. Since its half-life is 74 days, the problem is the method of its supply. From the standpoint of economy, this method is superior to the x-ray method; but this is not so if the frequency of uses is not high. (NSA of Japan)

12552 RADIOISOTOPE POWERED MARINE LIGHT. Ind. Electron., 5: 349(Aug. 1967).

A radioisotope Powered Prolonged Life Equipment (RIPPLE) generator was installed to provide electric power for a marine warning light placed offshore at Dungeness, England. The light marks the platform over the cooling water intake for the Dungeness nuclear power station. This generator operates on the heat produced by the radioactive decay of ^{90}Sr. An assembly of thermocouples converts the heat to electricity which is fed to the flashing light. At least 5 yr of continuous unattended operation will be obtained from the system which replaces an acetylene lamp. The RIPPLE generator was installed by the U. K. Atomic Energy Authority with the cooperation of Trinity House and the Central Electricity Generating Board. It was built by Submarine Cables Ltd., which is manufacturing RIPPLE generators under license from the UKAEA. (BBB)

12553 GEOMETRY AND BARRIER ATTENUATION OF ^{60}Co GAMMA RAYS BY A VERTICAL STEEL SLAB. Plummer, G. E. (Naval Radiological Defense Lab., San Francisco). Nucl. Sci. Eng., 31: 183-90(1968).

The barrier and geometry attenuation factors for ^{60}Co gamma rays were studied. A set of vertical, plane steel barriers was employed. Selection of the detector distance from a given barrier and the degree of collimation permitted exposures to be measured as a function of the solid angle subtended by a constant circular area on the barrier. The effective mass thickness of the barriers ranged from 0 to 73 lb/ft^2 and the solid angle subtended at the detector varied from 0.2 to 5.5 sr. A uniform plane radiation field was simulated by a traveling ^{60}Co source that was pumped through plastic tubing that covered a 100-ft semicircular area. Extrapolation of the experimental data gave estimates of the exposures to be expected from an infinitely extended field. The final results for a collimated detector, located behind a steel barrier, were normalized to the free-field exposure received by a detector located 3 ft above the extended field. The experimental values were compared to a family of curves based on calculated results. For all cases except those for relatively small solid angles, the agreement was within 20%. (auth)

12554 METHODS OF MEASUREMENT OF LIQUID FLOW IN OPEN CHANNELS. PART II. DILUTION METHODS. 2C. RADIOISOTOPE TECHNIQUES. British Standard 3680: Part 2C (1967). London, British Standards Institution, 1967. 48p.

This specification is concerned with measurement of turbulent flow in rivers and artificial channels using radioisotopes, by constant rate and sudden injection methods. It specifies the apparatus and isotopes to be used, and the techniques of injection, sampling and measurement. (UK)

Materials Testing

Refer also to abstracts 12484, 12485, and 12962.

12555 (ALO-3632-23) QUARTERLY PROGRESS REPORT OF RESEARCH AND DEVELOPMENT IN A THERMAL INSULATION STUDY, SEPTEMBER-NOVEMBER 1967. DeWitt, W. D.; Reid, R. L. (Union Carbide Corp., Indianapolis, Ind. Linde Div.). Jan. 22, 1968. Contract AT(30-1)-3632. 35p. Dep. CFSTI.

Thermal conductivity test data were obtained for the following insulations: aluminum foil-aluminum flake opacified glass fiber paper; aluminum flake opacified glass fiber paper; and copper flake opacified Refrasil quartz fiber paper. Long term thermal performance tests were initiated for these insulations to determine thermal stability as a function of time. Air exposure testing of the nickel foil-Refrasil quartz fiber paper combination was initiated. Three air exposure experiments were completed and a fourth is underway. The experimentally determined thermal conductivities were compared with those obtained from an analytical correlation. Mechanical design of the flat plate thermal conductivity test apparatus was completed and fabrication initiated. Two concepts for thermally guarding the insulation sample were analytically evaluated and sample guard specimens are being prepared. The Hastelloy-X vacuum enclosure test specimen has completed approximately 5000 hours of testing without leakage. (auth)

12556 (BNWL-473, pp 10.1-12) NONDESTRUCTIVE TESTING RESEARCH. Spanner, J. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The relative similarities of an R-C network model to an R-L network model are being investigated. It appears that the R-C model may prove useful in certain comparative studies of eddy current nondestructive testing. A theoretical and experimental study of eddy current probe design should lead to the development of better probes. Development work is underway on thermal wave transducers with solid rather than helium gas backing. An electronic analog is being prepared to check the remote transient infrared method now under development. The irradiation of steel for ultrasonic detection of nil-ductility transition temperature is being conducted in the ETR. (auth)

12557 (BNWL-528) NONDESTRUCTIVE TESTING OF ISOTOPE CONTAINMENT CAPSULES: PHASE I, SNAP-21, AND SNAP-23. Steffens, R. W.; Pedersen, H. N.; Coffman, F. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. 28p. Dep. CFSTI.

Because of the toxic and radioactive nature of the core material contained in isotope heat sources, the integrity of the container must be assured through a reliable quality control program. This program must include measurements capable of providing both quality assurance of the product and information feedback for process control. In the case of isotope containment capsules, standard radiographic techniques are not capable of detecting the small volume cracks typically found in the closure welds. To solve the quality control problem, an ultrasonic test system has been devised to provide accurate and reliable measurements of the container closure weld parameters. Specifically, tests have been devised to measure the depth of weld penetration, to detect cracks in the weld volume, and to detect excessive meltdown of the outer weld corner. The ultrasonic techniques developed for the evaluation of weld quality on the three-pass, peripheral end-cap weld on SNAP-21 and SNAP-23 isotope containment capsules are described, verification of the ultrasonic measurements using the results of extensive metallographic analysis is discussed, and the three-pass weld technique evaluated. (auth)

12558 (N-67-23261) RADIOGRAPHIC TECHNIQUES FOR RELIABILITY SCREENING OF RELAYS. Lesser, W. H.; Holcomb, R. A.; Trojanowski, G. F. (General Electric Co., Waynesboro, Va. Specialty Control Dept. General Electric Co., Syracuse, N. Y. Electronics Lab.). Sept. 30, 1966. Contract NAS8-20301. 66p. (NASA-CR-83535). CFSTI.

The use of x rays for identifying and locating defects in hermetically sealed relays is described. Three views through the three coordinate axes are required to detect all defects, although not all may be usable for relays with very high density sections. The radiographic methods were found to detect successfully metallic defects such as tramp metal, solder balls, weld flash, incomplete assemblies, and extra or damaged parts. The radiographic examination did not reveal the presence of low density contaminants such as hair, lint or insulation. Misaligned components and copper wires in excess of 0.002 inch diameter were readily discernible. The x-ray technique was found to be particularly effective for examination of blind final assembly operations, such as internal welds from can to frame and seal-off hole soldering. Details are given on optimum exposure and target to film distance. (STAR)

12559 RADIOGRAPHY USING PHOTO-NUCLEAR REACTION. Furuta, Junichiro; Hiraoka, Eiichi; Tsujii, Yukio. Annu. Rep. Radiat. Center Osaka Prefect., 7: 62-4(1966).

A method of radiography using the photonuclear reaction was developed to eliminate scattered photons generated in the sample. By this method, the contrast and definition of picture were very much improved compared to the ordinary film method. The measurable minimum diameter of penetrameter remained constant when the steel thicknesses were varied, and the fault sensitivity was 1% for 75 mm of steel thickness, instead of 2% as by ordinary film methods. Ag, In, and Ta are suitable metal plates to be used in this method. (auth)

12560 RADIOGRAPHY USING ^{192}Ir. II. Furuta, Junichiro; Hiraoka, Eiichi; Tsujii, Yukio. Annu. Rep. Radiat. Center Osaka Prefect., 7: 59-61(1966).

The best conditions of film density and fault sensitivity are reported in the case of radiography using ^{192}Ir. The measurements were made using the lead foils of several thicknesses and the wire and Bacillus-type penetrameters. (auth)

12561 METHOD OF MEASURING THE HARDNESS OF A METALLIC WORKPIECE. (to Industrial Nucleonics Corp.). British Patent 1,099,781. Jan. 17, 1968. Priority date Mar. 23, 1964, United States.

A method of nondestructive measurement of the hardness of materials having fairly constant homogeneous composition is described. A beam of β particles from a ^{85}Kr or ^{90}Sr source is directed on the surface of a hardness sample. The intensity of the backscatter is measured by a detector responsive to β particles to provide an electrical signal proportional to the intensity of the reflected radiation. (F.S.)

Radioactive Material Handling

Refer also to abstracts 12430, 12496, 12507, and 12510.

12562 (STI/PUB-170) BASIC FACTORS FOR THE TREATMENT AND DISPOSAL OF RADIOACTIVE WASTES. Safety Series No. 24. (International Atomic Energy Agency, Vienna (Austria)). 1967. 41p. IAEA: $1.00; S 26,-; 7/2 stg; F Fr 4,90; DM 4,-.

A guide to the factors which should be evaluated in selecting a waste management system is presented so that establishments, especially in developing Member States of IAEA, can choose the methods suitable for their particular needs. (auth)

12563 (JPRS-43977) CALCULATIONS OF HEIGHT OF VENTILATION STACKS FOR DISCHARGING AIR CONTAMINATED WITH RADIOACTIVE MATERIALS. Krupchatnikov, V. M. Translated from Vodosnabzh. Sanit. Tekh., No. 10, 30-4(1967). 15p. CFSTI.

A method for calculating the height of ventilation stacks for discharging air contaminated with radioactive materials is described. (L.C.L.)

12564 TRANSPORT OF SPENT NUCLEAR FUELS. Hiesinger, L. (Allgemeine Elektricitaets-Gesellschaft Telefunken, Frankfurt am Main). Atomwirt., Atomtech., 12: 516-19(Nov. 1967). (In German).

The disposal of spent power reactor fuel elements when their content of economically usable uranium-235 is exhausted has an increasing influence on the prime costs of power generation. Spent fuel elements from future nuclear power stations will represent large, megacurie sources of radioactive radiation and will generate heat continuously at a rate of the order of several kW/element. The physical, technical, and economic questions connected with the transport of irradiated nuclear fuels are closely interrelated. In addition to the normally applicable transport conditions the overriding safety aspects have to take into account all possible or conceivable cases of accident. The concept of a transportable safe for irradiated fuel elements from water-cooled power reactors is described. It is based upon the necessary safety requirements and is intended to accommodate 12 elements of 4 m length. An experimental program which includes deformation tests of the safe in which the 60 ton body is dropped from a height of 10 m on to a hard, unyielding surface is described. The safe is made from cast iron which is sufficiently ductile, impact resistant and stable in form. The heat generated by the spent fuel elements is absorbed and removed by air-water coolers. The fuel elements can be stored dry or be submerged in a primary water filling in the container. They are isolated from shock in an element carrier which can be changed to accommodate different sizes of element. Wet transport is in every case less severe since the rod temperature remains below 100°C. In case of overheating the container remains tight up to pressures of at least 70 atm. (auth)

12565 IMPROVEMENTS IN AND RELATING TO TOOLS FOR CHANGING NEEDLES FOR TAKING LIQUID, AND IN PARTICULAR RADIO-ACTIVE LIQUID SAMPLES. (to Commissariat a l'Energie Atomique). British Patent 1,100,306, Jan. 24, 1968. Priority date Apr. 23, 1964, France.

A remote-control instrument for changing needles used in handling radioactive liquid samples is described. (W.H.K.)

Vacuum Engineering

12566 FAST CRYOPUMP SYSTEM FOR ULTRA-HIGH VACUUM. Venema, A. (Philips Research Labs., Eindhoven, Netherlands). Philips Tech. Rev., 28: 355-61(1967).

Now that pumps are available which have a high pumping speed at low pressure, it is no longer particularly difficult to produce an ultrahigh vacuum ($<10^{-9}$ torr). The pumping time can be drastically shortened by cooling the wall of the system to about 50°K. This minimizes the rate of gas desorption. The Philips two-stage gas-refrigerating machine is particularly useful in such a system. The wall is then mounted on the first stage. The head of the machine (at about 12°K) is inside the vacuum and on top of it there is a copper plate which acts as a cryopump, i.e., it lowers the partial pressure of the gas components to their saturation pressure at 12°K. With an arrangement of this kind, 10^{-9} torr can be reached in one hour. If the system contains an internal heating source, as in a vacuum-evaporation equipment, a grid is arranged in front of the plate to shield it from radiation: the heat received by the grid is taken off through the first stage of the machine. (auth)

12567 INFRARED WINDOWS FOR ULTRAHIGH VACUUM USE. Schkolnick, Leon J. (American Can Co., Princeton, N. J.). Rev. Sci. Instrum., 39: 122-3(Jan. 1968).

A method for fabricating bakeable infrared windows for ultrahigh vacuum use is described. A blank stainless steel flange is drilled so that an infrared window is seated with a clearance of ~0.1 mm at its perimeter. The window and flange are cleaned with a solvent such as acetone. A low vapor pressure sealant such as a silicone resin like "Vacseal" is applied in liquid form. It starts to harden in a few min at room temperature. Curing at room temperature takes several days or it may be cured in a shorter time at high temperatures (15 min at 250°C). It is best to cure the seal before mounting the window to the vacuum system. This same method may be used for sealing a KBr window in stainless steel flanges for use in a vacuum monochromator. (F.S.)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 12659, 12855, and 12864.

12568 (AEEW-M-492) SOME COMMENTS ON NEW NEUTRON DETECTION DEVICES. Goodings, A. (Atomic Energy Establishment, Winfrith (England)). Dec. 1964. 15p. (CONF-641224-1). Dep.

From Conference on the Control and Operation of Nuclear Reactors, Saclay, France.

One fission chamber and three ionization chambers used for neutron flux measurements are described. The purposes of the measurements being reactor control and operational testing. (B.G.D.)

12569 (ANL-7311) PROGRESS REPORT ON THE SYSTEM FOR COMPUTER-OPERATED RADIATION EVALUATION. Wood, D. R.; Lord, W. L.; Bruckner, J. A. (Argonne National Lab., Ill.). Oct. 1967. Contract W-31-109-eng-38. 39p. Dep. CFSTI.

Some system and software design criteria for the development of a system for computer-operated radiation evaluation are discussed. Either scintillation or a solid-state radiation detector may be used. A supervisory program is discussed which services an analog-to-digital converter in real time. This program includes keyboard control of all operational functions such as clear data storage, data taking, display, integration, spectrum analysis, and count rate. Examples of application programs illustrate on-line control and analysis. (auth)

12570 (ANL-7380, pp 139) SOME CONSIDERATIONS ON SELF-POWERED DETECTORS FOR LMFBR SERVICE. Joslin, C. W. (Reuter-Stokes Electronic Components, Inc., Cleveland, Ohio).

Brief remarks are made on high-temperature service (~700°C) of self-power detectors. The gamma sensitivity of radiation detectors in LMFBR's is discussed. (B.G.D.)

12571 (ANL-7380, pp 146-7) MINIATURIZED NEUTRON FLUX SENSOR FOR LMFBR ENVIRONMENT. Kinzer, J. E.; Park, T. A. (Atomics International, Canoga Park, Calif.).

The ADIT (Advanced Development Irradiation Techniques) flux sensor has been developed at Atomics International to meet the need for in-core neutron-sensing devices. The device consists of a thermocouple in which fissionable material has replaced the oxide insulation around the measuring junction. The thermocouple is then welded closed in the normal fashion. The tip of the thermocouple is swaged to a smaller diameter. A cup is fitted over the swaged portion of the thermocouple and welded to the thermocouple sheath, forming an annular thermal barrier between the swaged thermocouple tip and inside diameter of the cup. The reliability and relatively long life of thermocouples and the fact that the only instrumentation required is the standard thermocouple recorder make the ADIT flux sensors attractive for in-core data acquisition. Since the type of fissionable material used may be chosen to match the neutron-flux environment of interest, this flux sensor is applicable to measurements of both fast and thermal fluxes. (auth)

12572 (ANL-7380, pp 164) NUCLEAR INSTRUMENTATION. Gilmour, G. A. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.).

The work being done on radiation detection and nuclear instrumentation in support of NERVA is discussed. Topics include measurements of gamma heating in calorimeters, fast nuclear instruments, and compensated ionization chambers. (B.G.D.)

12573 (ANL-7380, pp 165-7) MEASUREMENT OF NEUTRON FLUXES UNDER ADVERSE CONDITIONS USING CAMPBELL'S METHOD. Neissel, J. P.; Dayal, Y. (General Electric Co., San Jose, Calif. Atomic Products Div.).

A method is discussed for handling the signal from a linear neutron detector in such a manner that the effects of gamma irradiation and cable leakage are strongly suppressed. In particular, in-core fission chambers are linear devices (when operated on the dc plateau) that are very useful in reactor applications, but which suffer from the ill effects of gammas and cable leakage, especially when operated in an environment of fast neutrons and high temperature. (B.G.D.)

12574 (CEA-R-3190) DETERMINATION DE PENTE DE PALIER ET D'ACTIVITE A PARTIR DE RESULTATS DE MESURE FILTRES SELON LE CRITERE DE W. CHAUVENET (PROGRAMMES DE CALCUL EN MAGE II ET FORTRAN IV). (Determination of Plateau Slope and Activity Using Filter Measurement Results and W. Chauvenet's Criterion (MAGE II and FORTRAN IV Calculation Programmes)). Becker, Antoine (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1967. 54p. (In French). Dep.

To permit the objective comparison of plateau characteristics of gas-ionization counters, plateaus which are obtained when each radioactive sample from normal LMR production is measured, a program has been drawn up on an electronic computer comprising a processing section using least squares for obtaining the corrected plateaus and energies. With a view to an automatic operation of radio-measurement chains, the program also comprises a preliminary section in which statistical considerations have been applied; this has been done to eliminate measurement results which are dubious and even totally wrong. (auth)

12575 (Y-1595) AUTOMATED INSTRUMENTATION FOR IN VIVO RADIATION MONITORING. Cromwell, H. H. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Jan. 30, 1968. Contract W-7405-eng-26. 62p. Dep. CFSTI.

An in vivo spectrometer utilizes a small digital computer to collect, store, and process radiation data obtained from monitoring the internal body burdens of gamma-emitting radioisotopes. A significant feature of the instrumentation is the storage of differential rather than absolute spectra. (auth)

12576 LIFETIME OF NEUTRONS IN COSMIC-RAY NEUTRON MONITORS. Hatton, C. J.; Tomlinson, E. V. (Univ. of Leeds, Eng.). Nuovo Cim. (10), 53B: 63-72(Jan. 11, 1968).

Measurements of the time distributions of neutrons in the L.G.Y. neutron monitor have been made using two different origins of time: a) the time of the interaction in the monitor and b) the time of detection of the first neutron. These distributions are found to be different though consistent with each other. The real time distribution is not a pure exponential but rather the sum of two such functions. This is explained in terms of two distinct regions in which the neutrons are thermalized, the inner and outer moderator. The time distribution of neutrons in the NM-64 monitor is also determined. (auth)

12577 WIDE-RANGE PULSE-SHAPE DISCRIMINATION SYSTEM. Hollandsworth, C. E.; Bucher, W. P. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Rev. Sci. Instrum., 39: 165-8(Feb. 1968).

A pulse-shape discrimination system for use with organic scintillators is described which is based upon the true zero-crossing detection of single delay-line shaped pulses. Results of performance tests are presented in the form of contour diagrams which show the crossover-time spectra of neutron and gamma-ray induced events as a function of pulse amplitude. A technique to compensate for the variation of scintillation pulse shape with recoil-proton energy is described. Good gamma-ray rejection with nearly 100% recoil-proton acceptance over a dynamic range of 100 is obtained. (auth)

12578 NEW IONIZATION CHAMBER TECHNIQUE FOR THE MEASUREMENT OF ENVIRONMENTAL RADIATION. Shamos, M. H.; Liboff, A. R. (New York Univ., N. Y.). Rev. Sci. Instrum., 39: 223-9(Feb. 1968).

It is shown, contrary to usual low-level ion chamber practice, that there are unique advantages to using highly electronegative filling gases, which enhance columnar recombination. Indeed, through the proper choice of gas and electric field strength, it is possible to discriminate almost completely against alphas originating in the walls without affecting the collection of beta- and gamma-induced ionization. A number of chambers utilizing this technique have been constructed. The resulting characteristics, as well as comparisons with calibrated sources, indicate a complete absence of residual currents from wall contaminants. The fluctuations in background measurements are reduced by at least a factor of 3 over comparable air chambers. (auth)

12579 APPLICATION OF SILICON DAMAGE TO NEUTRON EXPOSURE MEASUREMENT. Poblenz, F. W. (Bendix Research Labs., Southfield, Mich.); Taulbee, C. D.; Walker, R. L. Contract AF 29(601)-7197. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 147-52(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

A technique is described for using the damage in silicon to measure neutron exposure in Radiation Damage Units (RDUs) with

transistors called Radiation Damage Monitors (RDMs). The technique is useful in measuring the damage gradients across experiments and in determining the relative damage effect of a neutron environment. Two calibration procedures are described, as are the operating characteristics and use procedures for five transistor RDMs to cover the exposure range from 10^{11} to 10^{15} n/cm.^{2} (auth)

12580 PULSED RADIATION ENERGY SPECTROMETER USING FERROELECTRICS. Miller, D. (Ohio State Univ., Columbus); Schlosser, P.; Burt, J.; Glower, D. D.; McNeilly, John M. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 245-51(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

The differential energy spectrum of a flash x-ray source or other pulsed radiation sources may be measured using the ferroelectric radiation detector. The detector, consisting of the poled ceramic lead zirconate titanate, exhibits a pulse charge output which is proportional to the absorbed dose. The spectrometer system itself employs a filtration technique where a set of energy-selective metal filters is positioned in front of a corresponding set of ferroelectric detectors, and the radiation induced charge output of each detector is measured. From this data the spectrum of the pulsed radiation source is deduced by the use of a numerical unfolding technique. Experimentally, the concept of the ferroelectric spectrometer system was verified by measuring the spectrum of a 0.6 MVP flash x-ray machine. Since the ferroelectric detector exhibits a dynamic response to the incident radiation pulse, the same spectrometer concept is used to measure the spectrum as a function of time. The time-dependent character of the flash x-ray machine spectrum was detected experimentally and the results showed that the energy spectrum is harder during the first portion of the pulse. (auth)

12581 RESPONSE OF THE NE213 SCINTILLATOR TO NEUTRON-INDUCED PROTON RECOILS. Dietzsch, O. (Univ., Sao Paulo, Brazil). An. Acad. Brasil Cienc., 39: 221-5(June 1967).

The pulse-height response of the organic liquid scintillator NE213 to neutron-induced proton recoils was measured for neutron energies between 0.3 and 3.8 MeV. The pulse-height is compared to the pulse height obtained from gamma-ray sources. The results are presented as the electron energy which yields the same pulse height as the maximum energy proton recoils from the neutron irradiation. A comparison is made with results of other authors. (auth)

12582 MULTIALKALI PHOTOMULTIPLIER TUBE, PM55. Endo, Kenji; Hojo, Takashi (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rebyu, 22: 1198-1202(Oct. 1967). (In Japanese).

The photomultiplier tube PM55 is provided with a transparent multialkali (Na-K-Cs-Sb) photoelectric surface at its top and ten stages of multiplying electrodes. This photoelectric surface, having high sensitivity equaling two or three times that of the conventional Cs-Sb or Bi-Ag-O-Cs surface, and excelling especially in red sensitivity, anticipates wide application of the tube in the fields where high S/N ratio is required. (auth)

12583 INSTRUMENTAL NOTE: A THYROID MONITOR OF HIGH SENSITIVITY USING A SHADOW-SHIELD. Boddy, Keith (Scottish Research Reactor Centre, Glasgow). Brit. J. Radiol., 40: 638-40(Aug. 1967).

A thyroid monitor of high sensitivity was developed for clinical trials of ^{131}I in the thyroid gland. The monitor may have wide application in allowing reduction in the administered dose in thyroid uptake studies. Three methods of improving sensitivity were considered: increasing the detector volume compared with the customary 2 in. diameter × 2 in. detector; reducing the background counting rate; and reducing the patient to detector distance compared with the recommended working distance of 25 cm. (auth)

12584 PROBLEM OF THE SPECTRAL SENSITIVITY OF X-RAY FILMS. Angerstein, W. (Forschungsinstitut fuer Tuberkulose und Lungenkrankenheiten, Berlin-Buch). Z. Wiss. Photogr. Photophys. Photochem., 60: 46-51(1967). (In German).

In x-ray photography with amplifier foils the film-foil combination is the most important factor that affects the degree of effectivity of any specific spectral wavelength. The emission spectrum of a commercially produced $CaWO_4$ amplifier foil excited by a ^{85}Kr β-radiation source was studied. The spectral emission was measured in equipment that consisted of a monochromator and secondary electron multiplier with known wavelength function. The foil emission was maximal at 425 nm, with a spectral half value width of 122 nm. The range of error of the maximum was ±8 nm. The maxima of the film and foil curves fell almost together, but the foil emission maximum fell only in the long wave end of the plateau-like sensitivity maximum. The amplifier foil emission in the short-wave area was used for picture production. The long-wave portion was only partially used for this. The film was almost insensitive to the wavelengths greater than 470 nm. The results indicated that for maximal adaptation between film and foil, which is required to minimize radiation injury to patients, it would be necessary to insure that x-ray films to be used with $CaWO_4$ foils would be sensitized for the spectral range from 470 to 550 nm. (BBB)

12585 A TRANSISTORIZED LINEAR PULSE AMPLIFIER. Kahlenbach, M. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 10: 251-5(Aug. 1967). (In German).

A linear pulse amplifier is described which is designed as main amplifier for solid-state detector measurements and also can be used for amplifying output pulses of scintillation counters. It has adjustable integration and differentiation time constants. The amplifier can be biased up to 1 V (e.g. 10% of the nominal output voltage range). The general structure and the operation of the basic amplification circuits are described. The results of measurement of some characteristic values (temperature stability of gain, non-linearity) are given. (auth)

12586 SCINTILLATION DETECTORS FOR LOW- AND VERY-LOW-ENERGY NEUTRONS. Diaconescu, A. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 19: 751-76 (1967). (In Rumanian).

Detection of thermal and subthermal (cold) neutrons in neutron scattering experiments represents a relatively new technique, requiring a scintillator with practically 100% efficiency while remaining nearly completely insensitive toward γ radiation. Fission, (n,α), and (n,γ) reactions are involved in the operation of most of the scintillators. The active material must have a high reaction cross section; therefore the isotopes ^{10}B, ^{6}Li, ^{114}Cd and ^{235}U are used most often. Three successive processes are involved in the detection of the neutrons: a nuclear reaction is induced in the active nucleus, creating a charged particle or a γ quantum which in turn excites luminescence in the phosphor directly or indirectly. The light passes then through the scintillator and produces a photoelectric effect on the photocathode. The ^{10}B and ^{6}Li isotopes are introduced in the form of B_2O_3 and LiO_2 or Li_2O in plastic and glass scintillators and as borates, metaborates and as soluble organic lithium and boron compounds in liquid scintillators. The selection criteria for detectors suitable for use in the horizontal beamholes of reactors were also examined. (Review article, 34 references). (TTT)

12587 FAST NEUTRON DETECTION WITH SOLID STATE DETECTOR. Okabe, Shigeru; Fukuda, Kyue; Sato, Yuji; Azuma, Toshio; Kurosu, Tatsuo. Annu. Rep. Radiat. Center Osaka Prefect., 7: 41-51(1966).

The fast neutron detectors are described, in which a solid state detector was used to measure the recoil protons from thick and thin polyethylene proton radiators. The efficiency was observed as 4.5×10^{-4} counts/neutron for neutrons of 3 MeV in the case of thick radiator. A proton telescope was tested to measure the neutron energy using $H^2(d,n)He^3$ and $Be^9(d,n)B^{10}$ neutrons. The efficiency was obtained as 4.8×10^{-6} with 35 percent resolution for 4-MeV neutrons. With modified detection system, the protons scattered in 45° with respect to the neutron beam were detected with 12 percent resolution for 14 MeV neutrons. (auth)

12588 EXPERIMENTAL DETERMINATION OF LUMINOSITY AND γ RADIATION ENERGY ABSORBED BY SCINTILLATION MONOCRYSTAL SCREENS MADE OF CsI(Tl) AND NaI(Tl). Gromov, Yu. V.; Zakharin, Ya. A.; Yakoboson, A. M. Defektoskopiya, No. 4, 35-41(1967). (In Russian).

The luminescence of monocrystal-scintillation plates made of various thicknesses of CsI(Tl) and NaI(Tl), produced by 3- to 17-MeV betatron bremsstrahlung was determined for various thicknesses of the absorber (steel). The variations of bremsstrahlung energy absorbed by CsI(Tl) and NaI(Tl) scintillators of various thicknesses and the linear μ-absorption coefficient dependence on screen thickness were computed. It is shown that the luminescence of the CsI(Tl) and NaI(Tl) screen is proportional to the fraction of the bremsstrahlung energy absorbed by scintillation in a wide γ beam. (R.V.J.)

12589 GAS SCINTILLATION COUNTER FILLED WITH ARGON. Ciarkowski, Adam; Machalica, Piotr; Pawlowski, Zdzislaw (Politechnic, Warsaw). Nukleonika, 12: 1195-1205(1967). (In Polish).

The argon-filled gas scintillation counter parameters were tested. In particular the relationship between the amplitude of scintillation flashes and content of impurities of molecular gases in argon was determined. Calibrated optical filters were used to determine the characteristics of the spectrum of the light output of argon scintillator. (auth)

12590 IN-CORE SYSTEM PROVIDES CONTINUOUS FLUX MAP OF REACTOR CORES. Foreman, C. E.; Hubbard, R. B. Power, 111: 106-9(Nov. 1967).

The description of a sophisticated in-core neutron monitoring system used at the Gudremmingen Nuclear Power Station is presented. It consists of a Local Power Range Monitoring System in conjunction with a Flux Mapping and Calibration System. The core-traversing neutron-flux mapping system helps optimize performance and calibrate safety monitors. (W.H.K.)

12591 IMPROVED SAMPLE VIAL CONSTRUCTIONS FOR USE IN STANDARDIZATION PROCEDURES INVOLVING LIQUID SCINTILLATION SPECTROMETRY EQUIPMENT. (to Packard Instrument Co., Inc.). British Patent 1,100,932. Jan. 24, 1968. Priority date June 18, 1964, United States.

The design of a sample vial for containing a test sample during the subjection of the sample to liquid scintillation spectral analysis is described. The system consists of a transparent receptacle for storing the liquid scintillator and the sample and a compartment for storing a standard radioactive source, with a shutter between the source and the sample. (auth)

12592 ARRANGEMENT FOR THE DETECTION OF ATOMIC PARTICLES. (to Osterreichische Studiengesellschaft fuer Atomenergie GmbH). British Patent 1,100,162. Jan. 24, 1968. Priority date Apr. 6, 1965, Austria.

A semiconductor detector system for analysis of atomic particles from mass spectrometers or mass separators is described. The energy of the particles and the length of the paths of the particles may be determined using a multichannel pulse analyzer. (W.H.K.)

12593 RADIATION INDICATING GLASS. Bishop, Frederic L. (to Owens-Illinois, Inc.,). U. S. Patent 3,359,125. Apr. 17, 1963.

A radiation-indicating glass consists of soda lime glasses and/or borosilicate glasses with a metal oxide(s) added as coloring agents. The metal oxide(s) is(are) selected from the group consisting of manganese oxide, cobalt oxide, and cerium oxide. The combination must always include manganese oxide and cobalt oxide in the range of from 0.04 to 0.10 wt % and 0.002 to 0.005 wt % respectively, based on the total glass forming oxide constituents. The cerium oxide is present in an amount from 0 to 0.2 wt %. The glass combination exhibits a slight blue coloration, which changes to a color ranging from colorless to a light neutral gray on exposure to sterilizing radiation. (Offic. Gaz.)

12594 IMPROVEMENTS IN OR RELATING TO RADIATION DETECTORS. (to Trilobe Coupling Corp.). British Patent 1,102,763. Feb. 7, 1968. Priority date Mar. 26, 1964, United States.

The design of a standard mounting assembly for providing environmental and mechanical protection for a number of interchangeable ionization detector tubes is presented. (W.H.K.)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 14281.

12595 (AAEC/E-186) NEUTRON TIME-OF-FLIGHT SPECTROMETRY FOR A CHOPPER WITH VANES LEAKAGE. Rocke, F. A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct. 1967. 46p. Dep.

A theory of neutron spectrometry for a chopper is presented which includes neutron leakage through the rotating slit vanes. Experimental checks of the theory are presented which involve differential spectrum measurements with a chopper on graphite-moderated neutrons from the reactor MOATA. Theory and experiment are in good agreement. (auth)

12596 (RHEL/R-154) NEUTRON SPECTROMETRY FROM 0.025 eV TO 25 GeV. Stevenson, G. R. (Rutherford High Energy Lab., Chilton (England)). Nov. 1967. 41p. Dep. CFSTI. UK. 6s. 0d.

An iterative unfolding method for response matrices reported by Gold (ANL 6984) was applied to the determination of neutron spectra from multisphere and activation analysis, and the work of Awschalom (PPAD-596E) was extended in that rules have been evolved for terminating the iteration sequence. Tests using analytic spectra to generate the detector responses used as input to the method indicate that confidence can be placed in the synthesized spectra when used with multisphere detectors, but that the method is unsatisfactory when used with activation detectors. (auth)

12597 (UUIP-651) DECAY DEPENDENT BACKGROUND SIGNALS IN A MAGNETIC ELECTRON SPECTROMETER. Kleinheinz, P.; Vukanovic, R.; Samuelsson, L.; Zupancic, M.; Krmpotic, D.; Besev, C.; Siegbahn, K. (Uppsala Univ. (Sweden). Inst. of Physics). June 1967. 41p. Dep.

Origin and intensity were studied of various types of background signals observed in a magnetic lens spectrometer. Quantitative representative results are given which can provide an order of magnitude estimate for the background intensity to be expected in a certain decay. It was found that scattered conversion electrons can give rise to sharp structures in the apparent electron spectrum, which are comparable to or even narrower than the instrumental resolution. Minimization of various types of backgrounds are shown by different counter measures. (auth)

12598 GERMANIUM DETECTORS AND THE COMPTON EFFECT. McDaniels, David K.; Battleson, Kirk (Univ. of Oregon, Eugene). Contract AT(45-1)-1925. Amer. J. Phys., 35: 837-43(Sept. 1967). (RLO-1925-08).

Recent advances in solid-state lithium-drifted germanium detectors have opened a new era in gamma-ray spectroscopy. A typical detector system is described which could easily be incorporated into an advanced teaching laboratory. The measurement and analysis of gamma-ray spectra from radioactive isotopes are reviewed. As an example of a further experiment, the Compton recoil distribution in a germanium crystal is compared with the Klein–Nishina prediction. Difficulties in making a quantitative comparison are discussed. (auth)

12599 PULSE-HEIGHT ANALYZER FOR CHARGED-PARTICLE SPECTROSCOPY ON THE LUNAR SURFACE. Harrington, T. M.; Marshall, J. H. (Analog Technology Corp., Pasadena, Calif.). Rev. Sci. Instrum., 39: 184-94(Feb. 1968).

The design and performance of a charge-sensitive amplifier and a 256-channel pulse-height analyzer for use in a lunar surface analysis experiment are presented. Input is from silicon detectors used to measure the energies of up to 7-MeV alpha particles and protons. Anticoincidence logic is provided for the proton detection system to reject cosmic rays. The instrument operates in the space environment over a temperature range of −50 to +50°C. Over this range the instrument gain was stable to ±0.4%, and the offset varied less than 0.1 channels. Resolution of 35 keV was obtained with a ^{228}Th alpha-particle source. Total power for the system, which includes 10 amplifiers, 2 analog-to-digital converters, 4 discriminators, and data processing logic, is approximately 2 W. Particular attention was given to reliability in the design and construction of the system. Large amounts of negative feedback and carefully selected and screened components were utilized to achieve this goal. (auth)

12600 GERMANIUM γ-RAY SPECTROMETERS. Mann, H. M. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 10-26(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Potential uses of the Ge(Li) diode detector as part of a spectrometer system for space experimentation would include identification of energy sources and determination of the composition of materials. In laboratory experiments its greatest application is in low-energy nuclear physics, mainly (n,γ) reaction studies. The primary advantage in its present use is energy resolving capability. In future applications, as energy resolution is maintained close to the observed limit for the detector, increased attention must be given to optimization in terms of geometry. Further improvements are needed in the mechanical design of such systems, especially for experiments in space. (auth)

12601 64-CHANNEL PROBE OF THE BORE-HOLE GAMMA-RAY SPECTROMETER. Palka, Karol W.; Turala, Michal (Inst. of Nuclear Techniques, Krakow). Nukleonika, 12: 1207-14 (1967). (In Polish).

The 64-channel probe of the bore-hole spectrometer for the gamma-ray energy (from 50 keV to 9.6 MeV) measurements is described. The scintillation counter with a NaI(Tl) crystal is used for radiation detection. The electronic system of the probe is constructed with semiconductor elements. The 3-core cable for the signal transmission and voltage supply is used. The maximum work temperature of this probe and the spectrometer dead time are respectively +40°C and 300 μsec. (auth)

12602 CORRELATION TYPE TIME-OF-FLIGHT SPECTROMETER WITH MAGNETICALLY PULSED POLARIZED NEUTRONS. Gordon, J.; Kroo, N.; Orban, G.; Pal, L.; Pellionisz, P.; Szlavik, F.; Vizi, I. (Central Research Inst. for Physics, Budapest). Phys. Lett., 26A: 122-3(Jan. 1, 1968).

A correlation type time-of-flight spectrometer was built for inelastic neutron scattering measurements. The main features of the experimental set-up and the first test runs are described. (auth)

High Energy Physics Instrumentation

Refer also to abstract 13874.

12603 (CERN–67-26(Vol.1)) INTERNATIONAL COLLOQUIUM ON BUBBLE CHAMBERS, HEIDELBERG, APRIL 13-14, 1967. Leutz, H. (ed.) (European Organization for Nuclear Research, Geneva (Switzerland)). Aug. 1967. 346p. (CONF-670416).

Separate abstracts were prepared for 21 of the 22 papers presented. One paper was previously included in NSA as 21: 26144. (B.G.D.)

For abstracts of individual papers see: 12604–12623 and 13874.

12604 (CERN–67-26(Vol.1), pp 3-23) FUTURE OF NEUTRINO PHYSICS WITH LARGE CHAMBERS. Lagarrigue, A. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire).

The advantages of large chambers for neutrino experiments are discussed in terms of increased event rate and increased information from each event. The importance of neutral particle detection in reactions of the types $\bar{\nu} + p \rightarrow \mu^+ + n$ and $\nu + n \rightarrow \mu^- + n + \pi^+$ is discussed. The different factors that will increase the number of events for the CERN chamber are summarized. Finally, a review is given of the neutrino physics to be performed with the large chamber: problems related to conservation laws; detection of intermediate boson; rare processes such as $\nu_\mu + e \rightarrow \mu^- + \nu_e$ and $\nu + p \rightarrow \nu + p$; processes related to weak baryon current; and test of CVC and PCAC. (L.B.S.)

12605 (CERN–67-26(Vol.1), pp 25-47) OPTIMIZATION OF BUBBLE CHAMBER DESIGN PARAMETERS: MEASURING ACCURACIES FOR CHARGED PARTICLES. Fisher, C. M. (Rutherford High Energy Lab., Chilton (England)).

The optimization of low- and high-energy bubble chamber design parameters are discussed. The low-energy parameters examined were angle and momentum measurements, chamber dimensions, and the choice of a suitable magnetic field. The high-energy parameters are those associated with charged particle track measurements at 20 to 30 GeV. (B.G.D.)

12606 (CERN–67-26(Vol.1), pp 73-86) THE LARGE HEAVY LIQUID BUBBLE CHAMBER GARGAMELLE. PHYSICAL ASPECTS AND EXPERIMENTATION. (Gargamelle Construction Group).

Various aspects of Gargamelle, the heavy liquid bubble chamber to be used at CERN in 1969, are presented. These include physical characteristics; liquids used such as pure freon (CF_3Br), pure propane, or any mixture of propane and freon; detection and measurement of neutral particles; measurement precision of charged particles; free proton density; particle identification; and polarization. The testing done with Slice, which is a scale model of Gargamelle with the same diameter but $^1/_{10}$ the length, is discussed. (B.G.D.)

12607 (CERN–67-26(Vol.1), pp 87-94) PHYSICS PLANS FOR THE 12-FT HYDROGEN BUBBLE CHAMBER. Derrick, M.; Burnstein, R. A. (Argonne National Lab., Ill.).

The plans for the ANL 12-ft hydrogen bubble chamber for neutrino physics experiments are outlined. The measurement of the neutrino spectrum is discussed. The actual event rates that can be obtained in the chamber are estimated. (B.G.D.)

12608 (CERN–67-26(Vol.1), pp 97-102) STATUS OF ANL 12-FT HYDROGEN BUBBLE CHAMBER. Pewitt, E. G. (Argonne National Lab., Ill.).

The evolution and present status of the ANL 12-ft hydrogen bubble chamber are discussed. Topics include conventional vs superconducting coils, iron yoke for the magnet, expansion system, optics and photography, temperature control, cryogenic supply system, and buildings. (B.G.D.)

12609 (CERN–67-26(Vol.1), pp 103-9) STATUS REPORT ON THE LARGE EUROPEAN HYDROGEN BUBBLE CHAMBER. (European Organization for Nuclear Research, Geneva (Switzerland)).

The general design aspects of the large European hydrogen bubble chamber to be located at CERN are presented. These include chamber dimensions, beam window, separation disc, expansion system, photography, magnet coils, cryogenic equipment, magnetic shielding, and location of chamber. (B.G.D.)

12610 (CERN–67-26(Vol.1), pp 111-33) THE LARGE HEAVY LIQUID BUBBLE CHAMBER GARGAMELLE. TECHNICAL ASPECTS AND PLANNING. (Gargamelle Construction Group).

The design aspects of Gargamelle, the heavy liquid bubble chamber to be used at CERN, are discussed. These include the magnet, chamber body, expansion system, illuminating system, cameras, transfer and storage of the liquids. The planning methods used for the bubble chamber are included. (B.G.D.)

12611 (CERN–67-26(Vol.1), pp 135-46) STATUS REPORT ON THE HYDROGEN BUBBLE CHAMBER MIRABELLE. Beauval, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

The design and construction of the Mirabelle hydrogen bubble chamber with a visible volume of 6,000 liters are reported. Topics included are physical dimensions, chamber body, expansion system, magnet system, refrigeration system, and vacuum system. (B.G.D.)

12612 (CERN–67-26(Vol.1), pp 147-65) STATUS REPORT ON RHEL: 1.5 m BY 70 kG HYDROGEN BUBBLE CHAMBER. (Rutherford High Energy Lab., Chilton (England)).

The design and construction of the RHEL hydrogen bubble chamber are reported. Topics include the magnet system, beam entry, optics, and the expansion system. (B.G.D.)

12613 (CERN–67-26(Vol.1), pp 181-9) STATUS REPORT ON A ONE METRE HYDROGEN TEST BUBBLE CHAMBER. (European Organization for Nuclear Research, Geneva (Switzerland)).

The design and construction of a 1-meter diameter hydrogen test bubble chamber for use in connection with the 3.5-meter hydrogen bubble chamber at CERN are discussed. A comparison between the two chambers is included. (B.G.D.)

12614 (CERN–67-26(Vol.1), pp 191-7) A PROPOSAL FOR A MAMMOTH HYDROGEN BUBBLE CHAMBER FOR USE WITH THE 300-GeV MACHINE. Thomas, D. B. (Rutherford High Energy Lab., Chilton (England)).

The construction techniques required to build a hydrogen bubble chamber with dimensions 15 meters in diameter and 6 meters in length ($\sim 10^6$ liters) are discussed. (B.G.D.)

12615 (CERN–67-26(Vol.1), pp 201-13) OPTICAL SOURCES OF DISTORTION IN BUBBLE CHAMBER PHOTOGRAPHY. Welford, W. T. (Imperial Coll. of Science and Tech., London (England)).

The main causes of asymmetric radial distortion and of tangential distortion in lenses are discussed. The design distortion in a lens, i.e., that computed by raytracing, is described. The pincushion distortion is shown to be caused by plane parallel plates, i.e., windows, on the object side, if the object is not at infinity. If the object space has a refractive index different from unity, e.g., liquid hydrogen, the effect is as if a plane parallel plate of thickness equal to the depth of the liquid were interposed: thus the distortion due to the liquid being bounded by a plane surface is a function of depth in the liquid. Asymmetry of lens or window surface figure and inhomogeneity of refractive index produce effective distortions. Errors in mounting and centering individual components produce to a first approximation an effective prism in the lens aperture, which distorts straight lines into curves by the usual prismatic spectrum line curvature effect. Uniform temperature changes affect mainly focus and scale of image. Stress birefringence in glass can produce image doubling which is very marked in windows which have been deliberately stressed to increase mechanical strength, i.e., tempered windows. The final possible cause of asymmetry discussed is Faraday effect rotation due to the magnetic field. (B.G.D.)

12616 (CERN–67-26(Vol.1), pp 215-28) OPTICAL DISTORTIONS IN BUBBLE CHAMBERS ARISING FROM TURBULENT CONVECTIVE MOTIONS. Thomas, D. B. (Rutherford High Energy Lab., Chilton (England)).

The two principal causes of thermal turbulence in bubble chambers are discussed. Deposition of a substantial amount of heat locally due to irreversible work performed during the bubble growth and recompression cycle is the first cause. The second cause of thermal turbulence is associated with the transfer of heat from a rigid boundary in the fluid either to or from the fluid. A heat exchanger is one such rigid boundary deliberately designed into the system, but any portion of chamber wall which differs in temperature from the adjacent fluid is just as effective. The method whereby this thermal turbulence arises at a heat exchanger is examined. The size of small eddies in the turbulence microstructure and its effect on optical distortions are evaluated. Finally an analysis is presented on electromagnetic wave propagation in a turbulent medium. (B.G.D.)

12617 (CERN–67-26(Vol.1), pp 229-42) GEOMETRICAL THEORY OF SCOTCHLITE. Courant, H. (Minnesota Univ., Minneapolis. Inst. of Tech.).

The reflective characteristics of Scotchlite, which is a reflective sheeting produced commercially by the 3M Company are discussed. The optical elements of Scotchlite consist of small beads of transparent material having high refractive index. Both the refraction and spherical aberration properties of Scotchlite are examined. Dark field illumination of bubble chambers in which no light is allowed to enter the camera pupil from the Scotchlite background directly is also discussed. (B.G.D.)

12618 (CERN–67-26(Vol.1), pp 243-61) INVESTIGATION OF DARK FIELD SCOTCHLITE. Bougon, M. (Argonne National Lab., Ill.).

In the ANL 12-foot hydrogen bubble chamber, the bright field system requires at least 600 μ bubbles which puts a strain on the chamber when one wants to grow these bubbles in 2 or 3 msec. Using dark field photography with FE 582 Scotchlite in air the usable bubble diameter can be decreased to 300 μ. The methods used to improve the contrast and reduce background light to enhance the quality of dark field photography are discussed. (B.G.D.)

12619 (CERN–67-26(Vol.1), pp 263-93) PHOTOGRAPHY, EXPANSION DYNAMICS, OPTICAL INHOMOGENEITIES OF THE MURA MODEL HEAVY LIQUID CHAMBER. Baumann, C. A.; Camerini, U.; Fry, W. F.; Gams, M. C.; Hilden, R. H.; Laufenberg, J. F.; Palmer, M. L.; Powell, W. M.; Sviatoslavsky, I. N.; Winter, W. R. (Wisconsin Univ., Madison).

The advantages and disadvantages of Scotchlite in bubble chamber photography are discussed. Several photographs of particle tracks are presented. The effects of expansion on liquid oscillations in a Freon bubble chamber are examined. Optical inhomogeneities due to thermal turbulences in bubble chambers are summarized. (B.G.D.)

12620 (CERN–67-26(Vol.1), pp 295-311) THE LARGE HEAVY LIQUID BUBBLE CHAMBER GARGAMELLE. THE OPTICS. (Gargamelle Construction Group).

The optical system for the heavy liquid bubble chamber Gargamelle is discussed. Topics include main requirements, description of the prototype and the final design, measurements with the prototype, and expected performances for the optimized system. (B.G.D.)

12621 (CERN–67-26(Vol.1), pp 313-27) PRELIMINARY STUDIES ON PICTURE ANALYSIS FOR GARGAMELLE. Fiorini, E.; Negri, P. (Milan Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Milan (Italy)).

Elementary particle interactions were simulated in a full scale optical model of Gargamelle with fiducial marks installed on the walls and inside the chamber. A brief description is given of procedures and a computer program reconstruction of the fiducial marks. The scanning and measuring projector for film analysis of particle tracks is described. (B.G.D.)

12622 (CERN–67-26(Vol.1), pp 329-40) DEVELOPMENT OF WIDE-ANGLE LENSES FOR THE ARGONNE 12 FT. BUBBLE CHAMBER. Welford, W. T. (Imperial Coll. of Science and Tech., London (England)).

The requirements of the lenses for the Argonne 12-ft bubble chamber are discussed. These include wide-field angle, telecentricity, small diameter front elements to permit a ring source for Scotchlite illumination, diffraction-limited correction of aberrations except distortion, to permit use of high-resolving power film (Kodak Microfile) at great demagnification, and small overall length. The design parameters established from these requirements are briefly outlined. (B.G.D.)

12623 (CERN–67-26(Vol.1), pp 341-6) OPTICS OF THE LARGE EUROPEAN HYDROGEN BUBBLE CHAMBER. (European Organization for Nuclear Research, Geneva (Switzerland)).

An investigation was made as to whether the beads in FE 582 Scotchlite are dislodged due to the frequent expansions and recompressions in a bubble chamber and represent problems to the piston at the bottom of the chamber. An investigation was also made as to whether parasitic bubbles form on the surface of the Scotchlite. The fisheyes to be used in the bubble chamber were also examined. (B.G.D.)

12624 (CERN–67-26(Vol.2)) INTERNATIONAL COLLOQUIUM ON BUBBLE CHAMBERS, HEIDELBERG, APRIL 13-14, 1967. Leutz, H. (ed.) (European Organization for Nuclear Research, Geneva (Switzerland)). Aug. 1967. 207p. (CONF-670416).

Separate abstracts were prepared for 16 of the 17 papers presented. One paper was previously included in NSA as 21:30685. (W.H.K.)

For abstracts of individual papers see: 12625–12640.

12625 (CERN–67-26(Vol.2), pp 349-69) VIBRATION OF BUBBLE CHAMBER LIQUID DURING EXPANSION. Dykes, M. S.; Bachy, G. (European Organization for Nuclear Research, Geneva (Switzerland)).

The determination of pressure distribution and pressure–time curves for a simple bubble chamber expansion system operating in a state of free oscillation is discussed. Pressure–time and pressure distribution curves are illustrated for specific piston mass–fluid mass ratios. (W.H.K.)

12626 (CERN–67-26(Vol.2), pp 371-7) POSSIBILITY OF A FAST CYCLING HYDROGEN BUBBLE CHAMBER. Badier, J. (Ecole Polytechnique, Paris (France)).

The operation of a hydrogen bubble chamber at 40 cycles per second is investigated. Parameters stipulated are operated at four atmospheres pressure and 27°K temperature. (W.H.K.)

12627 (CERN–67-26(Vol.2), pp 379-87) SPECIAL DEVICES FOR A FAST CYCLING HYDROGEN BUBBLE CHAMBER. Gregory, Ch. (Ecole Polytechnique, Paris (France)).

The design of a fast-cycling hydrogen bubble chamber is briefly described. The expansion system, thermal regulation, and optical system are discussed. (W.H.K.)

12628 (CERN–67-26(Vol.2), pp 389-404) ON THE FORMATION OF BUBBLES IN LIQUID HYDROGEN. Harigel, G.; Horlitz, G.; Wolff, S. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)).

Photographs of the tracks of 2-GeV electrons have been taken in the DESY 85-cm bubble chamber with a scale-one optical system in bright field illumination. Growth and recompression of bubbles as well as bubble densities have been observed between 24.5 and 28.0°K. Bubble sizes as a function of time have been measured at different temperatures, with expanded pressure and overpressure as varying parameters. A summary is given of the experimental results, and a comparison of different theories on the behavior of bubble growth and recompression is presented. (auth)

12629 (CERN–67-26(Vol.2), pp 405-12) BUBBLE DENSITY AND GROWTH OF BUBBLES IN PROPANE. Kunkel, P.; Christenn, G.; Scheer, M. (Wuerzburg Univ. (West Germany). Physikalisches Institut).

Using 20 MeV electrons from a betatron and a small 350-ccm pressure-stabilized bubble chamber, the primary bubble density and the rate of bubble growth in propane were investigated. The dependence of the temperature and the pressure drop on the working parameters are reported. (auth)

12630 (CERN–67-26(Vol.2), pp 413-24) TEMPERATURE MEASUREMENTS IN THE CERN 1 m^3 HEAVY LIQUID BUBBLE CHAMBER. Eberle, K. H. (European Organization for Nuclear Research, Geneva (Switzerland)).

Temperature distribution measurements, carried out in the CERN heavy liquid bubble chamber to obtain a better understanding of its thermal behavior and to determine the parameters necessary to improve its temperature regulation, are described. (auth)

12631 (CERN–67-26(Vol.2), pp 427-33) SUPERCONDUCTING MAGNET ASSOCIATED WITH THE ANL 12-FT HYDROGEN BUBBLE CHAMBER. Pewitt, E. G. (Argonne National Lab., Ill.).

A description of the 12-ft hydrogen bubble chamber, the cryogenic system, and the electrical circuit of the superconducting coil is presented. The 2000 amp coil is designed to produce a field of 18 kG. (W.H.K.)

12632 (CERN–67-26(Vol.2), pp 457-64) MAGNET DEVELOPMENT PROGRAM FOR THE LARGE EUROPEAN HYDROGEN BUBBLE CHAMBER. (European Organization for Nuclear Research, Geneva (Switzerland)).

A magnet development program to prepare the technical specifications of the coils arrangement for a 3.5 m hydrogen bubble chamber is outlined. Testing of superconductors under mechanical and magnetic stresses is discussed. (W.H.K.)

12633 (CERN–67-26(Vol.2), pp 467-71) CONTROL OF THE EXPANSION IN A HEAVY LIQUID BUBBLE CHAMBER BY ELASTICALLY SUSPENDED PLATES. Ramm, C. A.; Scherer, Ch. (European Organization for Nuclear Research, Geneva (Switzerland)).

To prevent membrane boiling at the 1.1 m^3 CERN heavy liquid bubble chamber, a freely suspended rigid plate was placed in front of the membrane to alter the membrane velocity distribution. The improvement in operation is discussed. (W.H.K.)

12634 (CERN–67-26(Vol.2), pp 473-8) EXPANSION SYSTEM FOR THE LARGE EUROPEAN HYDROGEN BUBBLE CHAMBER. (European Organization for Nuclear Research, Geneva (Switzerland)).

A resonant-type expansion system with a hydraulic locking device is described for a 3.5-m hydrogen bubble chamber. (W.H.K.)

12635 (CERN-67-26(Vol.2), pp 479-84) FLAT MEMBRANE INFLATABLE GASKET FOR A LARGE LIQUID HYDROGEN BUBBLE CHAMBER. Stierlin, R. G. (European Organization for Nuclear Research, Geneva (Switzerland)).

Gaskets are described for use in the CERN 2-m liquid hydrogen bubble chamber. They are designed to ensure leak tightness between the volume formed by the chamber and its attached safety tanks and the vacuum tank during cool-down and warming-up operations. (W.H.K.)

12636 (CERN-67-26(Vol.2), pp 485-92) OPTICS AND MAGNET OF THE HYDROGEN BUBBLE CHAMBER MIRABELLE. Gensollen, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

A description of the 20-kG aluminum-coil magnet system for the Mirabelle hydrogen bubble chamber is given. Also, the optical system, which utilizes a parabolic lens, is discussed. (W.H.K.)

12637 (CERN-67-26(Vol.2), pp 493-500) ENGINEERING ASPECTS OF THE ANL 12-FT HYDROGEN BUBBLE CHAMBER. Tamosaitis, A. (Argonne National Lab., Ill.).

Construction and operation of the 12-ft bubble chamber are discussed. The operating parameters, the photographic system, and the expansion system are considered. (W.H.K.)

12638 (CERN-67-26(Vol.2), pp 501-5) INSTRUMENTATION FOR THE ANL 12-FT HYDROGEN BUBBLE CHAMBER. Simpson, J. D. (Argonne National Lab., Ill.).

The floor plan for the control room is presented, and the general instrumentation used is outlined. A small computer is included as an automatic data logging system. (W.H.K.)

12639 (CERN-67-26(Vol.2), pp 507-11) EXPANSION SYSTEM FOR THE ANL 12-FT HYDROGEN BUBBLE CHAMBER. Simpson, J. D. (Argonne National Lab., Ill.).

The design criteria, problems, and operating principal of the expander for the ANL 12-ft bubble chamber are outlined. (W.H.K.)

12640 (CERN-67-26(Vol.2), pp 513-49) DESCRIPTION OF THE MECHANICAL AND ELECTRICAL COMPONENTS, GENERAL OVER-ALL OPERATION, AND EXPANSION STUDIES OF THE MURA MODEL HEAVY LIQUID BUBBLE CHAMBER. Baumann, C. A.; Camerini, U.; Fry, W. F.; Gams, M. C.; Hilden, R. H.; Laufenberg, J. F.; Palmer, M. L.; Powell, W. M.; Sviatoslavsky, I. N.; Winter, W. R. (Wisconsin Univ., Madison).

The design of the cylindrical Mura model bubble chamber is presented. The chamber has a 22.6-in. diameter and a 72-in. length. Problems encountered in the construction of the bubble chamber are discussed. Also, results on a study of the expansion system are outlined. (W.H.K.)

12641 NEW METHODS FOR THE DETECTION OF HIGH-ENERGY PARTICLES. Alikhanyan, A. I. pp 651-79 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

New methods for the recording and identification of high-energy particles are based on a gas discharge produced in spark track chambers, use of the logarithmic growth of energy losses in thin films for the determination of the energy and nature of particles (A. I. Alikhanian, Loeb Lecture Notes, Harvard University, 1965), and use of transfer radiation arising in connection with the passage of fast particles from a vacuum into a condensed medium. One may expect that gas-filled spark track chambers will be used extensively both in work on accelerators and in the investigation of cosmic radiation. In connection with the application of spark track chambers, recording of data directly on a magnetic tape followed by evaluation on a computer will prove feasible. A shortcoming of spark chambers is excessive memory, which interferes with the recording of events rapidly following each other. In chambers with a large gap, elimination of residual electrons which prolong the memory cannot be carried out by means of an electric field, but addition of impurities such as air, propane, alcohol, SO_2, and particularly CCl_4 is effective. To improve the isotropicity of spark track chambers, all 6 walls are used as electrodes and the high-voltage field is generated alternately in 3 directions. Transfer radiation arising as a result of passage of a particle from one medium into another with different electrodynamic properties differs from Cherenkov radiation in that it varies with the particle velocity to a much greater extent. It can be used to determine the energy of particles moving with a super-high velocity. (JPRS)

12642 APPLICATION IN CONNECTION WITH WORK ON ACCELERATORS OF TRACK SPARK CHAMBERS WITH THE SPARK TYPE OF OPERATION. Strauch, K. pp 680-96 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

The present state of development and application of spark chambers is reviewed. It is pointed out that spark track chambers with the spark type of operation (i.e., spark chambers with a large gap) promise to be a useful addition for the study of elementary particles on accelerators at high energies, both as far as measurement of angles and curvature is concerned. Spark track chambers with the streamer type of operation are superior to chambers with the spark type of operation as far as isotropicity is concerned, while the latter have a longer sensitivity period. The type of chamber that is preferable should depend on the nature of the experiment performed. (JPRS)

12643 COMPUTER ANALYSIS OF BUBBLE CHAMBER DATA. Solmitz, F. T. pp 697-707 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

The nature of data obtained with bubble chambers and the manner in which these data can be utilized are well known. In view of the increasing amount and complexity of the data obtained on bubble chambers, their expeditious analysis would hardly be possible without the application of computers. While initially IBM 650 computers were applied in the USA for this purpose, the more sophisticated CDC 6600 computers are coming into use at present: they have been purchased by CERN and will also be used at Berkeley and elsewhere. The FORTRAN language was found advantageous in the coding of computer data. (JPRS)

12644 PEPR. Pless, I. (Massachusetts Inst. of Tech., Cambridge). pp 708-33 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

The PEPR (Precision Encoding and Recognition Pattern) arrangement has been developed by means of which photographic data obtained on bubble chambers will be automatically scanned, events with a desired pattern recognized, the information on them transferred to magnetic tape, and the information on tapes evaluated on an IBM-7044 digital computer. At present, the selection of photographs is carried out visually and measurements made manually or by a projection system. The operation of PEPR amounts to recognition of linear elements of tracks with respect to coordinates and angles on the basis of information fed by an PDP-1 computer. The photographs are scanned by an electron ray tube and photomultiplier. Tracks crossing at angles $\geq 2°$ can be differentiated. (JPRS)

12645 SYSTEM APPROACH TO FAST LOGIC FOR COUNTER EXPERIMENTS IN HIGH ENERGY PHYSICS. Sippach, W.; Sunderland, J. (Columbia Univ., New York). Rev. Sci. Instrum., 39: 161-4(Feb. 1968).

A fast counter logic system is described that separates the time correlation and logic questions. A loose trigger generates a set of time windows for gating narrow discriminator pulses into storage elements. The stored signals are then logically combined into event definitions that are strobed to produce system outputs. Special emphasis is placed on use of the system with a data handler. Modules built for a counter hodoscope experiment are also described. (auth)

12646 COMPUTER APPLICATION IN HIGH-ENERGY PHYSICS. McKinney, Wayne R. (Johns Hopkins Univ., Baltimore). Vector (Baltimore), 12: 18-20(Nov. 1967).

Use of a computer to process data obtained from liquid H_2 bubble chamber tracks of high-energy particle interactions is described. Photographs of the bubble chamber are scanned for particular types of interactions. The scanner classifies each event found according to the Kopp code. After the scanning and cataloging process, the tracks on the film are measured on precision machines, which can determine the location of any bubble on the film to within a few microns. These coordinates are read off electrically and are sent to a PDP-8 computer, which transforms them into binary language and stores them on tape. The reconstruction of a Kopp 104 event with the data provided by this procedure is explained. (BBB)

12647 LIGHT SCATTERING BY BUBBLES IN A BUBBLE CHAMBER. Withrington, R. J. (Imperial Coll. of Science and Tech., London). Appl. Opt., 7: 175-81(Jan. 1968).

A discussion of the angular scattering expected from small bubbles in liquids of refractive indices 1.1 and 1.025 is given together with the inverse, i.e., of small spheres of the liquids air. The similarities between the two scattering functions are compared with a view to the simulation of bubble chamber tracks

using readily available materials. Fraunhofer scattering is significant on axis while larger angle scattering is geometrical. Some experimental verification of the scattering functions is also reported. (auth)

Radiation Dosimeters

Refer also to abstracts 12273, 12491, and 13035.

12648 (RISO–111) INVESTIGATION OF THE OXALIC-ACID SYSTEM FOR ^{60}Co DOSIMETRY. Holm, Niels W.; Bjergbakke, Erling; Sehested, Knud; Draganic, Ivan G. (Danish Atomic Energy Commission, Risoe, Research Establishment). Aug. 1967. 38p. Dep.

A review is given of the work done in oxalic-acid dosimetry, and a systematic investigation of the system for ^{60}Co dosimetry is described. A procedure for its use is added as an appendix. (DENMARK)

12649 (RISO–112) INFLUENCE OF DOSE RATE AT LARGE ABSORBED DOSES ON THE OXALIC-ACID DOSIMETER. Draganic, Ivan G.; Sehested, Knud; Holm, Niels W. (Danish Atomic Energy Commission, Risoe, Research Establishment). Aug. 1967. 18p. Dep.

A number of experiments dealing with the influence of high dose rates on the oxalic-acid dosimeter are described. A pulsed electron linear accelerator was used as radiation source. It is shown that the system may be used at dose rates up to 10^{10} rads/sec when an adequate initial concentration is applied and the irradiation field is reasonably homogeneous. (Denmark)

12650 (AD–663372) DOSIMETRY AND PROTECTION FROM IONIZING RADIATION. Golubev, B. P. Translated from pp 1-336 of Dozimetriya i Zashchita ot Ioniziruyushchikh Izluchenii, Gosudarstvennoe Energeticheskoe Izdatel'stvo, Moscow-Leningrad, 1963. 293p. (FTD-MT–64-291). CFSTI.

The material expounded in this book is based on the material of general physics course in technical institutions of higher education. The book corresponds to main sections of the course "Application of Atomic Energy in National Economy," introduced into curricula of these institutions of higher education by the Ministry of higher and intermediate specialized education of the RSFSR. Methods of ionizing radiation dosimetry and methods for the design of shielding for gamma radiation, for neutron radiation and for design of shielding in a nuclear reactor are described. (auth)

12651 THERMOLUMINESCENCE AND TRIBOLUMINESCENCE IN TRIOXANE CRYSTALS. Charlesby, A.; Gupta, P. S. (Royal Military Coll. of Science, Shrivenham, Eng.). J. Mater. Sci., 3: 70-5(Jan. 1968).

Polymerized trioxane crystals, irradiated at liquid nitrogen temperature, showed a single thermoluminescence peak on warming. Corresponding trioxane monomer crystals showed a thermoluminescence spectrum of five peaks, and a series of sharp spikes at irregular intervals. On warming an unirradiated crystal, a two-peak spectrum plus spikes was obtained. The spikes are associated with strong electrical discharges and are tentatively ascribed to dislocation of crystals under thermal stress. (auth)

12652 PROTON DOSIMETRY IN RADIATIVE CHEMICAL STUDIES OF IONIC SALTS. Oblivantsev, A. N.; Eremin, L. P.; Lykhin, V. M. (Tomsk Polytechnical Inst., USSR). Teor. Eksp. Khim., 3: 836-9(Nov.-Dec. 1967). (In Russian).

Proton dosimetry was evaluated using a known flux density during irradiation of heavy compounds having layers thinner than the particle trajectory. It is shown that the proton energy losses can be determined by theoretical calculations and experimental data on the radiative-chemical yields per particle. (tr-auth)

12653 DESIGN OF SOME MAJOR COMPONENTS FOR THE 4-GeV ELECTRON SYNCHROTRON NINA. Gallop, J. W. (Nelson Research Labs., Stafford, Eng.). Engl. Elec. J., 22: 39-48(Nov.-Dec. 1967).

The special design features of the power supply systems and vacuum chamber of Nina are described, with special reference to the resonant magnet network, the pulse valve, the bias current servo system (voltage loop, magnet current loop, rectifier grid conduction angle loop, pulse supply, pulse supply servo system, phase control loop), the energy storage choke, and manufacture of the vacuum chamber. (UK)

12654 POLYTETRAFLUOROETHYLENE AS A RADIATION DOSIMETER. Judeikis, Henry S.; Siegel, Seymour (Aerospace Corp., El Segundo, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 237-8(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

The utility of the quantitative assay of free radicals produced in polytetrafluoroethylene as a means of ionizing radiation dosimetry is discussed. Electron paramagnetic resonance spectroscopy is used as the diagnostic technique. It is shown that this dosimetry concept is very useful over the range 10^5 to 10^8 rad and that the range can be extended on both ends without much difficulty. Also, this material can be used to obtain depth-dose profiles in a straightforward manner. (auth)

12655 FEASIBILITY OF USING BORON LOADED NUCLEAR TRACK PLATES IN A PAIR OF SPHERICAL MODERATORS FOR MEASURING THE ENERGY OF NEUTRONS IN THE ENVIRONMENT. Vives, Melva V. (Philippine Atomic Research Center, Diliman). Philippines Nucl. J., 1: 83-92(Jan. 1967).

Using boron-loaded nuclear track plates in a pair of different size spherical moderators, it was shown that the average energy of multi-energetic neutrons in the environment can be estimated and the true energy of monoenergetic neutrons can be accurately measured; hence, a more accurate dosimetry of neutrons in the environment can be made. (auth)

12656 GAMMA-RAY DETECTOR USING INSULATING MATERIALS. III. LIQUID SCATTERER. Furuta, Junichiro; Hiraoka, Eiichi; Ohnishi, Tokuhiro. Annu. Rep. Radiat. Center Osaka Prefect., 7: 65-7(1966).

A liquid scatterer is used in the Compton dose-meter developed. The detector output is proportional to dose absorbed by scatterer and has almost the same value regardless of the kinds of liquid. The absorbed dose of liquid can be measured continuously and controlled in any values by regulating the flowing speed of liquid. (auth)

12657 ELECTRON BEAM DOSIMETRY BY TRIACETATE FILMS. Verkhgradskii, O. P.; P'yankov, G. N.; Chervetsova, I. N.; Kabakchi, A. M. (Inst. of Physical Chemistry, Kiev). Ukr. Fiz. Zh., 12: 1902-5(Nov. 1967). (In Russian).

Electron beam parameters and the spatial distribution of its energy absorbed in solid organic materials were determined by means of cellulose triacetate films. (R.V.J.)

12658 ENERGY ABSORPTION SPECTRUM-RADIATION DOSE CONVERSION OPERATOR. I. PRINCIPLE. Miyanaga, Ichiro; Moriuchi, Shigeru. Nippon Genshiryoku Gakkaishi, 9: 440-6(Aug. 1967). (In Japanese).

Hurst and Ritchie have presented a generalized concept for radiation dosimetry, which relates the response of detectors to the dose received by other systems of interest. This formulation can explain as a whole the principles of many kinds of detectors and methods used in radiation dosimetry, and is characterized by the introduction of the operator acting upon the energy absorption distribution function in a detector. In this connection, a new method of determining the generalized operator is presented, which permits the treatment of any type of radiation dose with any detector system, and its characteristics are discussed. Shown as examples are the generalized operator in an NaI(Tl) scintillation detector for the determination of γ exposure (R), and the same in a liquid scintillation detector for neutron dose equivalent (rem) measurement. (auth)

12659 MEASUREMENT OF DOSE EQUIVALENT USING PAIRED IONISATION CHAMBERS. Goodman, L. J.; Rossi, H. H. (Columbia Univ., New York). Health Phys., 14: 168-70(Feb. 1968).

The use of a two chamber system for mixed neutron and gamma fields is discussed. The neutron insensitive chamber is a non-hydrogenous device containing a CO_2 or Ar gas cavity surrounded by walls of teflon, carbon, or aluminum, with a neutron sensitivity depending on the wall and gas materials, the dimensions and geometry of the cavity, and the neutron energy. (UK)

12660 MILLIRAD AND MEGARAD DOSIMETRY WITH LiF. Goldstein, N.; Tochilin, E.; Miller, W. G. (Naval Radiological Defense Lab., San Francisco). Health Phys., 14: 159-62(Feb. 1968).

A LiF dosimeter to measure gamma-ray exposures between 10^4 and 2×10^9 R has been developed. Megarad dosimetry with LiF was achieved by measuring a high temperature (450°C) glow peak. In order to obtain these temperatures it was necessary to modify the heating and timing circuits in a commercial reader. With these modifications further improvements in reading milliroentgen exposures also became possible. The increased magnitude of the primary glow peak obtained by the higher heating rate allowed exposures as low as 1 mR to be measured with TLD-100 LiF. By using the two LiF dosimeters and the measuring techniques described, exposures can be determined over the range between 10^{-3} and 10^9 R, thereby encompassing a total of 12 decades. (auth) (UK)

12661 STATISTICAL STUDY OF ROUTINE LiF THERMOLUMINESCENT DOSIMETRY. Mather, R. L. (Naval Radiological Defense Lab., San Francisco). Health Phys., 14: 172-3 (Feb. 1968).

In an experiment subsidiary to one which utilized several thousand LiF thermoluminescent dosimeters several hundred at a time over a period of a few weeks, 500 dosimeters were exposed to precisely known amounts of ^{60}Co radiation at several levels in order to evaluate the routine performance of this particular example of a commercial service. The findings are discussed. (auth) (UK)

Radiometric Instruments

Refer also to abstract 12561.

12662 (AD-662764) TELEMETRY OF RADIOACTIVE RADIATIONS. Bragin, A. A.; Mikhaylovskii, V. N. Translation of Teleizmerenie Radioaktivnykh Izlucheni, Izdatel'stvo Akademii Nauk Ukrainskoy SSR, Kiev, 1963. 161p. (FTD-MT-65-434; TM-7500763). CFSTI.

Attempt is made to illuminate the basic questions of the theory and practice of construction of well radiometric apparatus with respect to its thermostability, effectiveness, and accuracy. The topics covered include statistics of reading and statistical errors, transmission effectiveness of detector signal, equipment errors and methods of decreasing them, integrators and correction of load characteristics, channel separation, thermostatic control of scintillation counters, and telemetric instruments for the investigation of radioactive radiation in wells. (J.F.P.)

12663 A GAMMA DENSITY GAGE WITH AUTOMATIC CORRECTION. Loeber, C. Isotopenpraxis, 3: 431-7 (1967). (In German).

A density gage provided with a scintillation counter is described enabling the fully automatic correction of instabilities of both the electronic circuits and the detector as well as of the decrease in activity and, consequently, attaining accuracy of measurement and long-time stability characteristic for density gages working with ionization chambers, by using a special technique of control. (auth)

12664 COATING THICKNESS GAGE FOR GALVANIZING PROCESS. Shimizu, Masami (Kobe Kogyo Corp., Japan). Kobe Kogyo Giho, No. 33, 16-28 (July 1967). (In Japanese).

A beta-ray backscatter type thickness gage for continuous measurement of zinc coating thickness in the galvanizing process is described. The backscatter-type coating thickness gage has so small S/N detection ratio that the disturbances in the radiation detecting system cause the large error of the indication. The self-balancing system (the null method) has been employed on the detecting part of this gage for reduction of such error. This article deals with the principle of the backscatter-type coating thickness gage, construction, and some experimental data. (auth)

12665 RADIOISOTOPES IN FOOD PROCESSING. I. RADIOISOTOPE INSTRUMENTS. Longstaff, R. M. (United Kingdom Atomic Energy Authority, Wantage, Eng.). Atom, No. 135, 14-19 (Jan. 1968).

The use of instruments incorporating radioisotopes in the food processing and packaging industries is described. Instruments covered include level gauges, package monitors, density gauges, thickness gauges, weighing systems, and moisture gauges. (UK)

12666 IMPROVEMENTS IN OR RELATING TO A TIMEPIECE. (to Benrus Watch Co., Inc.). British Patent 1,101,269. Jan. 31, 1968. Priority date June 22, 1965, United States.

The design of a radiometric chronometer consisting of a radioactive source, counter and circuitry for time display is presented. (W.H.K.)

Miscellaneous Instruments and Components

Refer also to abstracts 12437, 12953, 12985, 13020, 13418, 13440, and 14292.

12667 (ACRH-1000-33) VERSATILE INSTRUMENT FOR PHOTOSCAN ANALYSIS WHICH PRODUCES COLOR DISPLAY FROM BLACK AND WHITE PHOTOSCANS. Charleston, D. B.; Beck, R. N.; Wood, J. C.; Yasillo, N. J. (Argonne Cancer Research Hospital, Chicago). Sept. 1967. Contract AT(11-1)-69. 8p. (CONF-670948-2). Dep. CFSTI.

From Symposium on Radioactive Isotopes in the Localization of Tumours, London, England.

The system uses a cathode ray tube to generate a spot which is focused by a lens onto a plane which holds a photoscan transparency. The light transmitted through the negative is projected onto the photocathode of a photomultiplier tube. The voltage output of this tube is processed electronically before it is presented to a color television which is synchronized with the flying-spot-cathode ray tube for display. (W.H.K.)

12668 (AERE-R-5642) ASSESSMENT OF DATA FROM AN AUTOMATIC NEUTRON DIFFRACTOMETER INSTALLATION. Hall, J. W.; Turberfield, K. C. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1967. 10p. Dep. CFSTI. UK 1s. 9d.

The outputs from automatic neutron diffractometers present significant data handling, assessment, and presentation problems. At AERE Harwell these diffractometers are to be served by PDP-8 computer installations that will automatically assess the measured data as to its reliability and significance, reduce it and store it. The raw and reduced data can also be presented on demand on an oscilloscope/T.V. relaying system for visual assessment. In addition to the data handling facilities, programs will be available for crystallographic calculations needed for setting up crystal samples and for carrying out the measurements. Feedback facilities will enable erroneous or inadequate data to be measured either autonomously by program, or as initiated by the experimenter. (auth)

12669 (ANL-7380) PROCEEDINGS OF THE LIQUID METAL INSTRUMENTATION AND CONTROL, IDAHO FALLS, IDAHO, MARCH 1-2, 1967. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 190p. (CONF-670314). Dep. CFSTI.

Separate abstracts were prepared for thirty of the thirty-five papers presented. Six papers were previously included in NSA as 21: 22128, 25632, 34080, 34155, and 35567. (B.G.D.)

For abstracts of individual papers see: 12570-12573, 12670-12680, 14123-14128, 14236-14238, and 14244-14249.

12670 (ANL-7380, pp 65-9) PRESSURE TRANSDUCERS FOR NUCLEAR REACTOR APPLICATIONS. King, E. C. (MSA Research Corp., Evans City, Pa.).

A pressure gage is described for determining the gas pressure inside a fuel pin during reactor operation. The present specifications call for a device no more than $\frac{1}{4}$ in. in diameter and for satisfactory operation at 1200°F. The device consists of a sealing bellows and a null detector for the balancing inert gas. Preliminary gages have already been manufactured and tested in air at 1200°F. The pressure-sensing unit was less than 2 in. long. The standard pressure transducer for liquid alkali metal up to 1600°F uses a bellows also, but is forced balanced by a spring with a very small motion. (auth)

12671 (ANL-7380, pp 70-4) LIQUID-LEVEL DETECTORS FOR LIQUID METALS. King, E. C. (MSA Research Corp., Evans City, Pa.).

The inductance type of liquid-level detector utilizes a search coil in a protective well as the sensing element. The level is detected when the split coil is out of inductance balance due to the presence of a conducting fluid opposite the lower half of the coil. Models are available in a hand probe, a hi-lo alarm, and the continuous level detector. Operation in nonnuclear applications have been satisfactory to 1200°F. The resistance type of liquid-level detector utilizes a change in the resistance of the circuit due to the shorting effect of the liquid metal on touching the probe. These are normally single-position detectors. A later model will give continuous reading like the old J-Probes, but has the improvement of being a straight unit entering from the top. (auth)

12672 (ANL-7380, pp 75-8) LEAK DETECTION: SODIUM-WATER REACTIONS. Chamberlain, Harry V. (Atomic Power Development Associates, Inc., Detroit, Mich.).

Leak detection of sodium-water reactions in sodium-heated steam generators is necessary to minimize damage to the unit as a result of small leaks. Evaluation of leak-detection methods is included as a part of APDA's Sodium-Water Reactions Program. Work was initiated on establishing leak-detection criteria using as the basis the large-scale steam generator that Babcock & Wilcox have designed for a 1000-MWe reactor plant. Prediction of the behavior of hydrogen and oxygen in the B&W unit was based on results of field tests made in the Enrico Fermi Fast Breeder Reactor. These tests showed that a thermal-conductivity meter located in the cover gas could detect leaks equivalent to 0.01 cc/min, and that approximately 99 percent of the hydrogen generated is retained in the sodium. Because the B&W steam-generator system is so large, the rate of change in concentration of hydrogen

and oxygen is low, thus indicating that a very sensitive instrument would be required for early detection of leaks. The EFFBR results are also being used to predict the behavior of the hydrogen in APDA's test facility, Rig 10, and results of tests in this unit will be used in formulating the criteria. After the leak-detection criteria have been established, additional instruments such as the Blake Rhometer, UNC oxygen meter, and sonic devices will be reviewed and the applicable ones installed in Rig 10 for evaluation. (auth)

12673 (ANL-7380, pp 79-90) HIGH-TEMPERATURE ELECTRIC-RESISTANCE STRAIN-GAGE SENSORS. Lemcoe, M. M. (Atomics International, Canoga Park, Calif.).

A technical evaluation of two types of commercially available high-temperature electric-resistance strain gages, and a special high-temperature gage under development at the Liquid Metal Engineering Center (LMEC) is reported. These gages, the BLH Type HT 1212-5A, Microdot Type SG420, and the LMEC, were selected for evaluation because of the need for reliable electric-resistance strain gages for high-temperature stress or strain measurements, and process instrumentation in the temperature range from 900 to 1200°F. Instrumentation of this type is needed to determine or ensure component structural integrity and overall system reliability of fast breeder reactors. The results of this evaluation indicate that the BLH gage is not suitable as a 1200°F gage for measurements on austenitic stainless steel components which are subjected to both steady-state and transient temperature conditions at heating rates in excess of 5°F/sec. The Microdot gage, on the other hand, was found satisfactory for use on austenitic stainless steel components for temperatures up to 900°F, under both steady-state and transient conditions, at heating rates up to at least 30°F/sec. The LMEC gage was the only gage which showed sufficient promise to be considered for 1200°F applications. (auth)

12674 (ANL-7380, pp 91-101) HIGH-TEMPERATURE STRAIN GAGES AND DEFORMATION TRANSDUCERS FOR USE IN SODIUM ENVIRONMENTS. Ives, K. D. (Babcock and Wilcox Co., Alliance, Ohio. [Research Center]).

Two significant developments made in adapting the Microdot half-bridge containing a platinum–tungsten alloy encased in magnesium oxide and protected by an outer shell of stainless steel for use in sodium environments at high temperatures are described: a calibrating technique whereby the bonded gage characteristics of each gage can be obtained prior to actually bonding the gage to the structure under test; and techniques for protecting the gage elements for varying periods of time from the sodium environment. A basic transducer for measuring displacements of sodium will also be discussed and a linear variable differential transformer which can be used for both deformation and vibration measurements. (auth)

12675 (ANL-7380, pp 102-10) SODIUM-PURITY INSTRUMENTATION. Petrek, John P. (Atomic Power Development Associates, Inc., Detroit, Mich.).

Three resistivity meters, designed and manufactured in Great Britain, have been operated in a sodium facility for approximately four years. Evaluation data indicate that the units are less sensitive to oxygen in the form of sodium monoxide than to sodium hydride and sodium hydroxide. Major problems experienced with the temperature-compensation systems in the rhometers are outlined. Cells manufactured by the United Nuclear Corporation for detecting oxygen activity in sodium have been evaluated in the facilities at APDA. The cells respond in a predictable manner to injections of sodium monoxide. The units are sensitive to perturbations of sodium temperature in the sodium loop, and possibly to ambient temperature changes. Some problems in cell response have been encountered from switching a multiple number of cells to a common readout system. Sodium sampling and chemical analysis are being used as the standard for evaluating meter response. A program for the development of an in-line detector of hydrogen in sodium is being pursued. The unit has been extensively tested in gas and in static sodium systems for proof-of-principle determinations. (auth)

12676 (ANL-7380, pp 111-17) CARBON METER DEVELOPMENT: AN INTERIM REPORT. McKee, John; Caplinger, Wayne (United Nuclear Corp., Elmsford, N. Y.).

A meter for continuously measuring the carburizing potential in sodium systems is being developed. The meter is intended for use in sodium-cooled reactors, where it must be able to detect carbon contamination before permanent damage to structural elements can occur. (auth)

12677 (ANL-7380, pp 118-22) TECHNIQUE FOR CALIBRATION OF ELECTROCHEMICAL OXYGEN METERS. Goldmann, Kurt (United Nuclear Corp., Elmsford, N. Y.).

The equipment and techniques used for the calibration of oxygen sensors in potassium are described. Calibration data are presented. Comments are made on the high oxygen dissolution and gettering rates which were observed during the calibration runs with potassium. Attempts at using this technique for the calibration of oxygen meters in sodium are described. (auth)

12678 (ANL-7380, pp 123-5) COOLANT CHEMISTRY SODIUM LOOP OPERATING EXPERIENCE AT ATOMICS INTERNATIONAL. McKisson, R. L.; Murbach, E. W. (Atomics International, Canoga Park, Calif.).

Atomic International is carrying out a program called "Stability and Structural Alloys in a Fast Reactor Environment." This program involves the measurement of physical and mechanical properties of alloys in high-temperature sodium and the effects of impurities normally present in sodium. One aspect of this program is to maintain the purity level of the sodium at a desired level. A 150-gal-capacity, 10-gpm-flow rate loop having cold and hot traps was used to accomplish this goal. The equipment for monitoring the performance of the loop and to measure or describe the composition of its sodium are described. These were a plugging meter, an oxygen meter, and a sample station. (B.G.D.)

12679 (ANL-7380, pp 161-3) COMPENSATED IONIZATION CHAMBER FOR THE NERVA REACTOR. Lupica, L. A. (Westinghouse Electric Corp., Elmira, N. Y. Electronic Tube Div.).

A compensated ionization chamber, the WX-5362, has been developed for use in the NERVA program as a neutron-flux detector for reactor control. The chamber has been designed to withstand the extremes of radiation, temperature, shock, and vibration associated with the NERVA reactor. (auth)

12680 (ANL-7380, pp 183-8) APPLICATION OF NOISE-ANALYSIS TECHNIQUES TO HYDRAULIC MEASUREMENTS IN LIQUID-METAL SYSTEMS. Randall, R. L.; Logan, D. (Atomics International, Canoga Park, Calif.).

Instrumentation and analysis techniques are described for detecting and studying: onset of boiling, void formations and movement; velocity profiles; flow patterns; and mixing and cross flow in hydraulic systems. The basic technique involves amplifying, filtering, recording and analyzing induced or inherent, periodic or random, fluctuations from electronic transducers sensitive to temperature, conductivity, flow rate, vibrations, etc. Primary emphasis will be placed on discussion of experiments presently underway, involving use of permanent-magnet flowmeters for detection of boiling in a sodium test loop. Flowmeter signals are used to detect the onset of boiling and cut off power to electrical heaters. (auth)

12681 (ANL-7393) ION-RETARDING LENS TO IMPROVE THE ABUNDANCE SENSITIVITY OF TANDEM MASS SPECTROMETERS. Kaiser, Kurt A.; Stevens, Charles M. (Argonne National Lab., Ill.). Nov. 1967. Contract W-31-109-eng-38. 10p. Dep. CFSTI.

The design, construction, and performance of a retarding lens used to increase the abundance sensitivity of tandem magnetic-analyzer mass spectrometers are described. Under typical operating conditions in a 30-cm-radius, two-stage system, the abundance sensitivity improved by a factor of about 10 on the high-mass side and about 10^3 on the low-mass side. (auth)

12682 (NPA/Int.-65-31) SOME DESIGN CONSIDERATIONS OF A LASER TRIGGERED IMPULSE GENERATOR. (European Organization for Nuclear Research, Geneva (Switzerland)). Dec. 6, 1965. 9p. Dep.

The use of a laser for triggering a spark gap switch for a pulse generator is discussed. Topics presented include laser beam induced breakdown, initial electron production using coherent radiation, laser beam induced conduction in gases, problems associated with laser triggered switches, and an experimental laser triggered impulse generator. (W.H.K.)

12683 (ORNL-TM-1909) RANDOM PULSE GENERATOR FOR TESTING NUCLEAR INSTRUMENTATION. Baldry, R. H. (Oak Ridge National Lab., Tenn.). Nov. 15, 1967. Contract W-7405-eng-26. 19p. Dep. CFSTI.

When testing nuclear instruments, such as a pulse-height analyzer or a time-of-flight analyzer, it is useful to have a source of pulses that are random in time, but have a fixed amplitude, and whose mean rate is stable, yet can be adjusted easily. Random pulses for this purpose are usually obtained from a radioactive source, detector, amplifier, and discriminator; the output rate is thus dependent upon the gain and threshold of the system. A random pulse generator (ORNL model Q-3029A-1) was developed in which the radioactive source is replaced by a noisy avalanche diode. The output rate is determined by the number of amplified

noise pulses exceeding a discriminator threshold, and the mean rate is stabilized by observing the output with a rate meter and controlling the avalanche diode standing current. The measured time distribution of output pulses from the pulse generator closely matched the calculated Poisson distribution, using a computer program to analyze the results. Output mean rates from 100 Hz to kHz can be selected; the mean-rate stability exceeds most measurement requirements. The unit is constructed in a 5-¼ in. high, single-width nuclear instrument module (NIM). (auth)

12684 (UCRL-17639) THE "SQUARE LOOP" FLUX STANDARD: A PRECISION PULSE GENERATOR. Macondray, Frederick W. (California Univ., Berkeley. Lawrence Radiation Lab.). June 23, 1967. Contract W-7405-eng-48. 13p. (CONF-670705-17). Dep. CFSTI.

From 2nd International Conference on Magnet Technology, Oxford, England.

A square-loop flux standard (called SLUFUS) is a simple and reliable device for calibrating a search coil and integrator magnetic-field-measuring system. A reproducible $\int V \cdot dt$ pulse is generated by reversing the magnetization of a temperature-controlled, temperature-compensated, toroidal-core transformer. The core is a Ni–Fe alloy with a square hysteresis loop. Output pulses in the range 0.01 to 1.0 volt-second (10^6 to 10^8 maxwell-turns) can be selected. Accuracies of 0.03% and better are achieved with relatively simple circuits. Subjects discussed include typical uses, operation of the basic device, temperature compensation of the toroid, performance history, and design example. (auth)

12685 (UCRL-17642) THE RAPID MAPPER: A DATA-ACQUISITION SYSTEM FOR LARGE-SCALE MAGNETIC FIELD MEASUREMENTS. Macondray, Frederick W. (California Univ., Berkeley. Lawrence Radiation Lab.). July 5, 1967. Contract W-7405-eng-48. 20p. (CONF-670705-18). Dep. CFSTI.

From 2nd International Conference on Magnet Technology, Oxford, England.

An automated measuring system, called the Rapid Mapper, was built in 1962 and rebuilt in 1964 for large-scale digital magnetic-field mapping. This machine is designed to perform a variety of automatic and semi-manual dc measurements. In the automatic modes the machine positions a probe, sequences the measurements, and records the data for later computer analysis. The semi-manual modes are used when computer analysis of manual data is desired. A third-generation Rapid Mapper, which is now in the planning stage, will be controlled by a small digital computer. It will contain all the capabilities of the preceding machines. In addition it will make digital pulsed field measurements and do error checking at the time of measurement. The use of a computer will greatly facilitate modification of test programs. Discussed are organization of the system, probe positioning, and flow diagrams of the control logic. (auth)

12686 (UCRL-50341) DESIGN AND TESTING OF A 100,000-psi EDDY-CURRENT PRESSURE TRANSDUCER FOR HOSTILE ENVIRONMENTS. Field, John E. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 10, 1967. Contract W-7405-eng-48. 11p. Dep. CFSTI.

This report describes the design and testing of an eddy-current pressure transducer capable of transmitting accurate signals over long cables when subjected to a maximum pressure of 200,000 psi, high-level gamma and neutron radiation, and accelerations several thousand times that of gravity. The minimum breakdown voltage of the system is 3000 volts. It was tested to 165,000 psi by means of an air gun operating through an amplifier using indium as the pressure-transmitting medium. (auth)

12687 (Y-1602) THERMISTOR TEMPERATURE CONTROL CIRCUIT. Henry, J. J. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Feb. 5, 1968. Contract W-7405-eng-26. 13p. Dep. CFSTI.

An improved temperature-control circuit has been designed that employs a thermistor bridge with a nonlinear reference leg and a single-ended transistor amplifier. This circuit provides regulation to within ±0.3°C for control at any selected temperature between −40 and +70°C. The nonlinear reference leg allows reduction in the number of components, thus improving the reliability without sacrificing accuracy. (auth)

12688 (AEC-tr-6929) DEVELOPMENT OF AN IN-CORE VOID METER. Satomi, Masahiro; Yusa, Hideo; Oda, Akira; Uga, Takeo; Mochizuki, Keiichi. Translated from Keisoku To Seigyo, 3: 69-75(1967). 17p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Two types of electronic void meters, a solenoid type and a digital type, with high sensitivity and the ability to withstand high temperatures, high pressures, and high radiation fields are described. They have been used in the JPDR to measure void fractions in the upper section of the chimney and the downcomer outlet. The principle and construction of the void meters, detector circuits, and measurement results are presented. (W.H.K.)

12689 PRELIMINARY EXPERIMENT ON THE INDUCTION-COUPLED ARGON PLASMA AT ATMOSPHERIC PRESSURE. Ohji, Michio (Kyushu Univ., Japan); Akazaki, Masanori. Rep. Res. Inst. Appl. Mech. (Kyushu Univ.), 16: 1-10(1966).

The characteristics of the rf (3.2Mc) induction-coupled argon plasma at atmospheric pressure are studied with special reference to the condition of gas flow. Method of starting and operation of the main discharge are almost the same as Reed's plasma torch, but two modes of the predischarge are clearly distinguished: The "spiral mode" and the "pencil mode." The effect of vortex stabilization on the main discharge was confirmed by feeding the gas flow into the discharge tube either tangentially or axially. The dependence of the plate current I_p of the oscillator circuit on the gas flow rate Q, with the plate voltage V_p being fixed, was shown and a V-shaped extinction curve was obtained on the Q-V_r plane. (NSA of Japan)

12690 LASER ALIGNMENT SYSTEM FOR THE STANFORD THREE-KILOMETER-LONG ACCELERATOR. Herrmannsfeldt, W. B.; Spranza, J. J. (Stanford Univ., Calif.). Lasers Opt. Non Conv., No. 8, 89-93(1967).

A laser alignment system, consisting of a helium–neon laser, a photoelectric detector, and a large number of lenses, is described. The detector consists of a mechanical scanning system and a photomultiplier with output equipment capable of resolving a shift of 0.025 mm. The targets are rectangular Fresnel-zone plates. (W.H.K.)

12691 DEVELOPMENT OF AN IN-CORE VOID METER. Satomi, Masahiro (Hitachi Ltd., Japan); Uga, Takeo. Trans. Soc. Instr. Contr. Eng., 3: 229-35(Sept. 1967). (In Japanese).

In order to measure steam void fractions in operating Boiling Water Reactors, two types of void-meter, solenoid type and digital type, were developed. The former consist of a solenoid, a high frequency oscillator, a bridge and other suitable electric circuits and detects impedance change induced by voids passing through the solenoid. The latter uses a thin needlelike electrode as detecting head and detects the changes of capacitance and resistance induced when the electrode collides with and penetrates a bubble. Since the changes of impedances induced by void were very small, special electric circuits were also devised to detect the small signals. The solenoid type void-meter responds promptly with high sensitivity, and is suitable for measuring mean void fractions in the solenoid under transient conditions, while the digital type void-meter is small in size and is applicable to measuring time-averaged local void fractions. These performances were examined through out-pile experiments. The detecting heads of the void-meters were designed and manufactured with special considerations so as to be used under the conditions of high temperature, high pressure and high irradiation. These void-meters were used to measure void fractions in the chimneys and in the downcomer of operating reactor JPDR (Japan Power Demonstration Reactor; a boiling water reactor with natural circulation). (auth)

12692 ISOTOPE ANALYSIS BY MASS SPECTROMETRY IN THE FIELD OF NUCLEAR ENERGY. Vastel, J.; Coulon, M. Atompraxis, 13: 571-4(1967). (In German).

The mass spectrometers built by CSF(Compagnie Générale de Télégraphie Sans Fil), with the help of the CEA, and some of the methods for analysis are described. (auth)

12693 HEATING SYSTEM FOR NMR SPECTROMETER. Golike, R. C.; Sieczka, P. M. (E. I. du Ponte de Nemours and Co., Inc., Buffalo). Rev. Sci. Instrum., 39: 273-4(Feb. 1968).

A simple inexpensive heating system was developed for the Varian D.P. 60 NMR spectrometer. Although it lacks accurate control and range of operation of a commercial system, it was found to be satisfactory for a large amount of qualitative and in many cases quantitative work. (B.G.D.)

12694 SYNCHRONOUS OPERATION OF MASS SPECTROMETER. Kende, Paul (E. I. du Pont de Nemours and Co., Wilmington, Del.). Rev. Sci. Instrum., 39: 270(Feb. 1968).

A solid-state electronic circuit was developed which controls the spectrum generation of a Bendix time-of-flight mass spectrometer and synchronizes it to the chemical reaction under study. (B.G.D.)

12695 SUPERCONDUCTING GYROSCOPE: DRIFT DATA AND MATHEMATICAL MODEL. Harding, John T. (Ford Motor Co., Newport Beach, Calif.); Lawson, Donald B. Con-

tract NAS 7-100. AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 305-11(Feb. 1968).

Drift data are presented for an experimental cryogenic gyroscope which consists of a spinning superconducting sphere levitated in a vacuum by a magnetic field. A Fourier analysis of the data has yielded estimates for the parameters in a relation $\tau = A_1 \sin\alpha + A_2 \sin\alpha \cos\alpha + A_3 \sin\alpha\,(5\cos^2\alpha - 1) + A_4 \sin\alpha\,(7\cos^3\alpha - 3\cos\alpha)$, which expresses the dependence of torque on the angle α between the rotor spin axis and the vertical symmetry axis of the levitation field. These parameters can be related to rotor defects: mass-unbalance, nonsphericity, and trapped flux. Mass-unbalance is the main source of drift. The magnitude of drift due to nonsphericity is consistent with the measured variation in radius of the rotor (±7 μin.). Trapped flux is the least source of torque as a result of magnetic shielding during cool-down. (auth)

12696 BLANKING CIRCUIT FOR A MAGNETIC ELECTRON MULTIPLIER IN A TIME-OF-FLIGHT MASS SPECTROMETER. Haumann, Joseph R.; Studier, Martin H. (Argonne National Lab., Ill.). Rev. Sci. Instrum., 39: 169-70(Feb. 1968).

A blanking generator was developed for use with a magnetic electron multiplier in a time-of-flight mass spectrometer. By blanking out superfluous portions of the mass spectrum, nonlinearity in the electron multiplier is minimized, gain is increased, and dirtying of the dynode strip is retarded. (auth)

12697 VERY LOW FREQUENCY INTEGRATING VIBRATING SAMPLE MAGNETOMETER (VLFVSM) WITH HIGH DIFFERENTIAL SENSITIVITY IN HIGH dc FIELDS. Foner, S.; McNiff, E. J. Jr. (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instrum., 39: 171-9(Feb. 1968).

A vibrating sample magnetometer is described which is specifically adapted for magnetic moment measurements in high dc fields. The sample is moved at very low frequencies between series opposing detection coils, the induced voltage is integrated, and each cycle is recorded so that the output can be further time-averaged. Two novel aspects make this instrument particularly useful for high field measurements. First, the sample is moved beyond the center of the detection coils so that positioning errors, forces, and other incidental effects are eliminated. Second, a precise reference balance voltage is synchronously applied to the output signal to permit high-resolution differential measurements of magnetic moment. In addition to a detailed description of the basic VLFVSM, a general discussion of flux integration techniques is presented. Operation of the VLFVSM with field modulation superimposed, variable temperature, variable pressure, additional electronic filtering, and under swept-field conditions is discussed. Mechanical and electronic details and typical operating characteristics are included. The entire magnetometer has moderately high sensitivity, is extremely rugged, versatile, and eliminates sources of error present in many sample extraction techniques. All components, excluding the mechanical systems associated with the sample, are available commercially. This magnetometer has been applied to practically all types of high field magnetic moment measurements including differential susceptibility measurements in metals, alloys and insulators, superconductors, and highly anisotropic materials such as the rare earth metals. (auth)

12698 FAST RESPONSE MAGNETOMETER USING FERROMAGNETIC RESONANCE IN THIN FILMS. Schwee, L. J.; Irons, H. R. (Naval Ordnance Lab., Silver Spring, Md.). Rev. Sci. Instrum., 39: 220-2(Feb. 1968).

A magnetometer of simple construction is described having a response time of the order of 4 nsec. In this instrument the impedance of a thin film biased near ferromagnetic resonance is a measure of the external field. At resonance the element may be matched to a transmission line. The voltage amplitude of the reflected wave varies linearly with change in the external magnetic field. (auth)

12699 PULSE LIMITER. Sundelin, R. M. (Carnegie-Mellon Univ., Pittsburgh). Rev. Sci. Instrum., 39: 251-3(Feb. 1968).

Many of the high speed commercial logic circuits currently in use are readily damaged by overloads which can originate in photomultiplier socket assemblies due to a number of causes. A pulse limiter designed for the protection of such circuits is described. (B.G.D.)

12700 NMR FREQUENCY SWEEP USING A VOLTAGE CONTROLLED OSCILLATOR. Gillies, D.; Schaumburg, K. (National Research Council, Ottawa). Rev. Sci. Instrum., 39: 262-3(Feb. 1968).

In the investigation of a number of fluorine-containing compounds, attention was drawn to some basic inconveniences in the design of the lock system V4354A used in the Varian HA60/HA100 spectrometers. (B.G.D.)

12701 THERMAL ANNEALING OF PROTON-IRRADIATED SILICON SOLAR CELLS. Faraday, Bruce J.; Statler, Richard L.; Tauke, Regina V. (Naval Research Lab., Washington, D. C.). Proc. IEEE (Inst. Elec. Electron. Eng.), 56: 31-7(Jan. 1968).

Solar cells made from 1.5- and 10-Ω · cm p-type silicon, with silver-titanium evaporated electrodes, were irradiated by 4.6-MeV protons at room temperature to fluences ranging from 10^{10} to 10^{12} protons/cm^2. The photovoltaic current-voltage characteristics, the photovoltaic spectral response, and the minority carrier diffusion length were studied as the solar cells were annealed isochronally to temperatures up to 600°C. The proton radiation damage annealed in two stages, the first occurring between 50 and 150°C, and the second between 350 and 450°C. The removal of proton damage in this manner differs markedly from the annealing reported for 1-MeV electron damage, where practically no recovery of the photovoltaic properties is observed below 350°C. At any selected annealing temperature, the 10-Ω · cm cells were observed to recover to a slightly greater degree than the 1.5-Ω · cm type. (auth)

12702 CONTINUOUS FILM MEMORY CELL FOR SUPERCONDUCTIVE ASSOCIATIVE MEMORIES. Kadereit, H. G.; Goser, K. (Forschungslab. Siemens AG, Munich). Proc. IEEE (Inst. Elec. Electron. Eng.), 56: 121-2(Jan. 1968).

A storage cell for an associative memory is described which offers a simpler structure and a higher packing density than cryotron storage cells. (auth)

12703 THE THEORY, EXPERIMENTAL DATA, AND SOME APPLICATIONS OF HIGH PERVEANCE ELECTRON GUNS. Zinchenko, N. S. (Inst. of Radiophysics and Electronics, Kharkov). Ukr. Fiz. Zh., 12: 1828-38(Nov. 1967). (In Russian).

The principle of a longitudinal compression of a charge in an electron beam with a constant cross section is described as a basis for operation of high perveance three-electrode guns. On the ground of the theory of beam similarity (namely, from a beam similarity criterion) the fundamental theoretical formula — for current density and perveance of the beam under formation, for the dependence between the potentials of the first and second diagrams — as well as the ratio for modeling the high perveance guns are received. The experimental checking of the theory of the high perveance guns was carried out by means of the three-electrode guns described in the article which form beams with the circular and rectangular cross sections. The obtained experimental results are characterized by high values of the perveances of the beams at the emergence out of the gun [up to 150 ($\mu A/V^{3/2}$)], high coefficients of the passing current (approximately 90 + 98%) and the possibility of the beam power to change under direct current. The perspectives are discussed of applications of high perveance three-electrode guns to vacuum microwave electronics, development of plasmic microwave generators and amplifiers, to X-ray technique and high vacuum ion sources. (auth)

12704 DIFFERENTIAL LINEARITY MEASUREMENTS. Goursky, V.; Guillon, H. (CEN, Saclay, France). Onde Elec., 47: 1385-94(Nov. 1967). (In French).

Growing resolution of pulse-height analysers requests a better knowledge of their differential linearity. During the two past years, successive improvements have been brought to the methods and instrumentation so that a few minutes are enough to evaluate nonlinear defects of less than 1% in usual practice, and as small as 0.1% with special procedure. These methods are described. (auth)

12705 COMPARISON OF VARIOUS ANALOG-TO-DIGITAL CONVERSION METHODS. RESULTS OBTAINED WITH A LARGE NUMBER OF CHANNELS WILKINSON PULSE HEIGHT ANALYSER. Goulee, P. F. Onde Elec., 47: 1378-84(Nov. 1967). (In French).

Several analog-to-digital converters using various techniques, and designed for nuclear pulse height analysis, are reviewed. This survey mainly compares characteristics such as: differential linearity, integral linearity and conversion speed. Some definitions and measurements methods are given. Finally results obtained with an industrial Wilkinson analyzer featuring a large number of channels are given. (auth)

12706 INTEGRAL AND DIFFERENTIAL LINEARITY OF AN ANALOG-TO-DIGITAL CONVERTER USING THE SUCCESSIVE APPROXIMATION METHOD. Andre, G.; Bloquet, L.; Brun, J. C.; Hrisoho, A. (Institut de Physique Nucleaire, Orsay, France). Onde Elec., 47: 1372-7(Nov. 1967). (In French).

The authors describe an analog-to-digital converter designed for nuclear pulse height analysis, using the successive approximation method. The causes producing differential nonlinearity and the necessary conditions for their elimination are examined. Some applications for this type of converter are suggested. (auth)

12707 CHARGE SENSITIVE PREAMPLIFIER WITH A HIGH RESOLUTION. Libs, G. (Service d'Instrumentation Nucleaire, Saclay, France. CEN, Saclay, France). Onde Elec., 47: 1368-71(Nov. 1967). (In French).

A charge sensitive preamplifier with a resolution of 1.1 keV fwhm (Ge) at room temperature is described. The input stage is mounted with two paralleled field effect transistors. It has an output capability of ±10 volts through a 100 Ω load impedance. The amplitude distortion due to pile-up effects is low. (auth)

12708 RESOLUTION OF A FIELD EFFECT TRANSISTOR PREAMPLIFIER IN A SPECTROMETRY UNIT. Freycenon, J.; de Rosny, G. (CEN, Saclay, France). Onde Elec., 47: 1363-7(Nov. 1967). (In French).

The calculus of the resolution of a charge sensitive preamplifier equipped with a field effect transistor is presented. Conclusions are drawn to direct the realization of these preamplifiers. (auth)

12709 NUCLEAR SPECTROMETRIC AMPLIFIERS. Samueli, J. J.; Balland, J. C.; Pigneret, J.; Sarazin, A. (Institut de Physique Nucleaire, Lyon). Onde Elec., 47: 1357-62(Nov. 1967). (In French).

The operating principles of nuclear pulse amplifiers are described. The shaping of the pulse, so as to minimize the noise and pile-up distortion is studied. The performances of some networks, giving unipolar or bipolar pulses, have been computed. (auth)

12710 NUCLEAR INSTRUMENTATION, NO. 30. Instrum. Nucl. (Paris), No. 118, 1-70(Sept. 1967). (In French).

The functional elements for nuclear instrumentation developed under the RENATRAN and ESONE standards are described. The general rules of the ESONE–RENATRAN system are outlined. The low voltage power supplies designed for use with the functional elements and the preamplifiers used with the RENATRAN functional elements are described. A table of RENATRAN functional elements available is presented. The characteristics of these functional elements are then described in some detail. Some measurement devices that can be constructed from the RENATRAN functional elements are discussed. (J.S.R.)

12711 SINGLE ELECTRON RESPONSE AND AFTERPULSING IN PHOTO- AND ELECTRON MULTIPLIERS. DeLaney, C. F. G.; Harwood, J. A. (Trinity Coll., Dublin). Sci. Proc. Roy. Dublin Soc., Ser. A, 3: No. 5, 57-67(Oct. 1967).

A study of single electron response in photomultipliers, and some deviations from the theoretical curves based on Poissonian statistics, was made. It is shown that the excess of small pulses in a venetian blind type tube is not due to satellite pulses following genuine single electron pulses. Afterpulses, however, were found to occur and were investigated in the foregoing tube and in a Bendix continuous channel multiplier. The afterpulsing mechanism is shown to be different for the two types of tube. (auth)

12712 DEVICE FOR READING A SCALER. Quivy, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,098,449. Jan. 10, 1968. Priority date Sept. 3, 1965, France.

An apparatus is described for reading a scaler having an input terminal to which pulses to be recorded are applied and having counter elements of successive orders. The apparatus is composed of means to read the order of the highest order counter element which has undergone a change of state and means to read the state of such highest order counter element. (W.H.K.)

12713 TEMPERATURE-GRADIENT-INSENSITIVE RESISTANCE-TYPE LIQUID METAL LEVEL DETECTOR. Briggs, N. H.; Burton, C. M.; Greene, G. W. (to United States Atomic Energy Commission). U. S. Patent 3,369,401. Feb. 20, 1968.

A level detector is described which compensates for the effect of voltages due to temperature gradients within the detector and thermoelectric voltages generated between the level detector and a liquid metal. Two identical probes, each consisting of a metal sheath containing a pair of wires attached to a closed end of the sheath, are permanently attached to a metal vessel containing the liquid metal. The probes are connected to a voltage source so that the thermoelectric emf's are generated along the submerged length of both probe sheaths and cancel each other. (AEC)

12714 SEMICONDUCTOR LEAD CUTTER. Caraisco, George F.; Elischer, V. P. (to United States Atomic Energy Commission). U. S. Patent 3,367,223. Feb. 6, 1968.

A hand tool for trimming semiconductor lead wires to uniform length without causing vibrational damage to the wafer-lead junctions is described. The device includes a base having a notched edge for receiving a predetermined length of the leads, a cutting arm pivoted to cut against the edge, and a complementary-notched damping block which is spring mounted on the arm to seat against the leads during the cutting action. (AEC)

12715 FAST MULTIPLIER EMPLOYING FIELD-EFFECT TRANSISTORS. Miller, G. L.; Radeka, V. (to United States Atomic Energy Commission). U. S. Patent 3,368,066. Feb. 6, 1968.

Multiplier circuits employing field-effect transistors are described. The field-effect transistor functions as a variable conductance controlled by the reverse bias of the gate-channel junction, with direct proportionality existing for signals well below saturation value. This characteristic is utilized to produce multiplication with the advantages of accuracy, speed, stability and simplicity. (AEC)

12716 OVERVOLTAGE PROTECTION CIRCUIT FOR CONDENSER DISCHARGE SYSTEM. Schofield, Aldred E.; Holm, Robert O. (to United States Atomic Energy Commission). U. S. Patent 3,368,135. Feb. 6, 1968.

A condenser discharge system employing an overvoltage safety circuit is described. A capacitor is discharged through the safety circuit by the action of a spark gap which employs a third electrode in such a manner that the electrode continually arcs in the spark gap and the gap is always ionized. (AEC)

12717 METHOD OF MASS SPECTROMETRY EMPLOYING A HIGH-FREQUENCY TRANSVERSE ELECTRIC FIELD. Gautherin, Guy; Septier, Albert (to Commissariat a l'Energie Atomique). British Patent 1,100,481. Jan. 24, 1968. Priority date Jan. 31, 1964, France.

A method of mass spectrography is described where a monoenergetic ion beam is subjected to an homogeneous high-frequency electric field which is perpendicular to the ion beam. The frequency of the electric field may be varied to selectively admit only certain ions for analysis. (W.H.K.)

12718 RADIATION MEASURING INSTRUMENT. (to North American Aviation, Inc.). British Patent 1,100,693. Jan. 24, 1968. Priority date June 1, 1964, United States.

A method for self-calibration of radiometric instruments due to radiation source decay or component instability is described. A secondary radiation source is used and a multichannel pulse analyzer compares the pulses from the two sources and generates a feedback control signal for continuous adjustment of the system. (W.H.K.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 13570, 13572, 13573, 13575, 13576, and 13581.

12719 DESCRIPTION OF SPACE ENVIRONMENT, ILLUSTRATION OF ITS EFFECTS ON MATERIALS. Faugere, J. F.; Elbaz, C. (Centre National d'Etudes Spatiales, Bretigny-sur-Orge, France). Onde Elec., 47: 1263-8(Nov. 1967). (In French).

Space and spacecraft environment are investigated, and each parameter is illustrated by an experiment of either the Centre National d'Etudes Spatiales or the NASA as follows. Particles trapped in the magnetic field have significantly damaged the silicon solar cells experiment on the D1-A satellite. A description of Fr-1 satellite thermal coating ageing by the uv electromagnetic radiation is given. Orbital temperature curves for FR-1 and D1-A are given to illustrate the thermal cycling in space vacuum. Finally micrometeoric effects on surfaces are illustrated by NASA experiments. (auth)

12720 A DESIGN PROCEDURE FOR RADIATION HARDENING CERTAIN NOR GATE LOGIC CIRCUITS. Maurer, Harold E. (Electronics Research Center, Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.) Trans. Electron. Comput., EC-16: 519-22 (Aug. 1967).

A design procedure is presented which produces reliable switching and computing circuits constructed of a particular NOR gate logic element with its individual, radiation-induced, permanent-damage failure mechanism. The NOR gate failure mechanism was experimentally determined to be a reduction in minimum fan-out with increased nuclear particle flux. The procedure is a flexible building block approach which may allow a given diagram to be hardened with a minimum expenditure of components and assures that adequate statistical information can be accumulated for reliability analyses although the method fails at sufficiently high levels of flux since the transistor current gains approach unity. The results should be applicable to the hardening of other NOR gate logic curcuits that are constructed with silicon transistors. The constraints on the hardening procedure imposed by fan-in and fan-out restrictions result in a set of equations which can be viewed as an integer linear programming problem. The limitations on the existence of a solution to this programming

problem are also the limitations on the existence of this type of permanent-damage-radiation-hardened logic diagrams. (BBB)

12721 RADIATION INDUCED CONDUCTIVITY AND DAMAGE OF THE ELECTRIC INSULATOR. Okabe, Shigeru; Tsumori, Kunihiko; Tabata, Tatsuo; Nakamura, Shigeki. Annu. Rep. Radiat. Center Osaka Prefect., 7: 31-7(1966).

Radiation induced conductivity and damage were observed with a linear accelerator to know the order of obstructive current in the study of irradiation concerned phenomena. The most important factors are considered to be the induced current, conductivity drift due to temperature rise and after effect of radiation damage. A permanent increase of conductivity was found for forsterite, a kind of ceramic. Explanation of observed phenomena is still difficult. (auth)

12722 ANNUAL CONFERENCE ON NUCLEAR AND SPACE RADIATION EFFECTS, OHIO STATE UNIVERSITY, COLUMBUS, OHIO, JULY 10-14, 1967. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 1-320(Dec. 1967). (CONF-670708).

Separate abstracts were prepared for 39 of the 42 papers presented. Three papers were previously included in NSA as 21: 36346, 21: 40069, and 22: 8428. (W.H.K.)

For abstracts of individual papers see: 12579, 12580, 12600, 12654, 12723-12742, 13292, 13466, 13532, and 13570-13581.

12723 MECHANISMS OF RADIATION EFFECTS OF LASERS. Compton, D. M. J.; Cesena, R. A. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 55-61(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Lasers offer many potential advantages for space communications and space instrumentation. Their performance is, however, affected by the high-energy radiation found in the space environment, e.g., trapped proton and electrons, solar flare protons, and possibly gamma rays and neutrons from on-board nuclear power, auxiliary or propulsive. Reported are some studies of the effects observed on lasers and laser components exposed to irradiation, and in particular on the mechanisms of these effects. (auth)

12724 FACTORS INFLUENCING PREDICTION OF TRANSISTOR CURRENT GAIN IN NEUTRON RADIATION. Frank, M.; Taulbee, C. D. (Bendix Research Labs., Southfield, Mich.). Contract AF 29(601)-7110. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 127-33(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Prediction of transistor performance in neutron radiation is subject to many variables. Several of these were investigated in order to improve prediction accuracy. Experimental data are discussed for the base transit time parameter, variation in damage with different bias conditions during irradiation, changes in damage observed after room-temperature storage and repeated high current measurements, and junction capacitance as a function of measurement frequency before and after irradiation. (auth)

12725 ANALYSIS OF RADIATION EFFECTS IN SEMICONDUCTOR JUNCTION DEVICES. Gwyn, C. W.; Scharfetter, D. L.; Wirth, J. L. (Sandia Lab., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 153-69(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

A computer program has been written for the prediction of transient and permanent radiation damage in junction devices. This program calculates the transient solutions of Poisson's equation and the continuity equations throughout a one-dimensional structure. Mobility, lifetime, and carrier generation are described by nonlinear functions of carrier density and current so that scatter-limiting velocity, Shockley-Read-Hall recombination, and avalanche ionization phenomena are described. Three examples are presented which illustrate the utility of such programs in predicting both ionization and displacement damage effects in a p-i-n diode and a bipolar transistor. (auth)

12726 COMPUTERIZED MODEL FOR RESPONSE OF TRANSISTORS TO A PULSE OF IONIZING RADIATION. van Lint, V. A. J.; Alexander, J. H.; Nichols, D. K.; Ward, P. R. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AF29(601)-7048. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 170-8(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

A computer program has been formulated to solve the time-dependent differential equations describing electron and hole concentrations and the electric field in one-dimensional planar semiconductor-device geometry. The usual assumptions of small minority-carrier concentration and requirements for separating devices into neutral and space-charge regions are not required since the depletion layer is a natural result of the computer solution. Problems which have been studied include the relaxation of P-N junction diodes and transistors from an intense short pulse of ionizing radiation. The phenomena observed include an apparent long recovery time of diodes in high-impedance circuits, ambipolar diffusion of electron-hole pairs toward the junction of alloy diodes, and electric-field peaking in the depletion layer of reverse-biased alloy junctions. (auth)

12727 SCR SWITCHING WITH IONIZING RADIATION. Raburn, W. D. (Univ. of Alabama, Tuscaloosa). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 187-9 (Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

A model is developed that predicts the critical dose of ionizing radiation required to trigger a semiconductor-controlled rectifier (SCR) as a function of device parameters and biasing. This model also expiains the long delay time observed between the ionizing pulse and device switching. The model makes use of the charge control concept. In general, computer solutions are required. A linear approximation is also developed that gives a good estimate in many cases. A method to obtain all parameters needed in the model is presented. (auth)

12728 ELECTRON INDUCED NOISE IN STAR TRACKER PHOTOMULTIPLIER TUBES. Favale, A. J.; Kuehne, F. J.; D'Agostino, M. D. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 190-4(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

The induced noise produced as a result of the impingement of electrons and X-rays on star tracker photomultiplier tubes has been investigated. Noise in this sense is anode current that is not due to an intended light signal, but which results from electron or x-ray irradiation. Anode current as a function of electron beam current density was measured for both shielded and unshielded RCA tubes 1P21, C70129C, and 8571. The anode current was found to vary linearly with electron beam current density. The shielded tubes were found to exhibit a 300-fold reduction in anode current density over the unshielded tubes. From this data it could be inferred that 2.6 MeV electrons are an order of magnitude more efficient in producing anode current than the x-rays resulting from stopping these electrons in $\frac{1}{4}$-inch aluminum shields. The mechanism of this noise production was also studied, it was found that the major source of the noise is from luminescence in the glass envelope of the tubes, the remainder being due to recoil electrons in the area of the photocathode. (auth)

12729 EFFECTS OF NUCLEAR RADIATION AS PART OF THE TEMPERATURE-VACUUM-POWER ENVIRONMENT. Klippenstein, E. (Jet Propulsion Lab., Pasadena, Calif.); Hanks, C. L.; Hamman, D. J. Contract NAS7-100. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 195-9(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Various electronic parts were exposed to combined environments such as temperature, vacuum, and nuclear radiation. A brief summary of the total results is presented with a more detailed description of the results obtained on the 2N 911 transistor. (auth)

12730 SENSITIVITY OF PHOTOGRAPHIC FILM TO NUCLEAR RADIATION IN NEAR-EARTH MISSIONS. Noon, Edward L. (EG and G, Inc., Santa Barbara, Calif.); Brown, Richard R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 200-3(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Seventeen commercially available films were evaluated for their sensitivity to ionizing radiation during a projected near-earth orbital mission. Although the evaluating technique described is not rigorous, it is useful in obtaining engineering estimates of tolerable radiation exposure levels for films used in near-earth orbital missions. (auth)

12731 A RADIATION EFFECTS LARGE SIGNAL EQUIVALENT CIRCUIT FOR MOS TRANSISTORS. Long, D. M. (Martin Marietta Corp., Baltimore). Contract DA28-043 AMC-01520(E). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 210-16(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

A large signal equivalent circuit which can be used to predict the behavior of MOS transistors in a pulsed radiation environment is presented. MOSFET behavior is interpreted wholly in terms of standard circuit elements which correspond closely to the operating principles of the device. The channel current is expressed as a single equation of the terminal voltages, which permits direct application of the model to many of the existing TREE computer codes. The model is generalized to encompass n- or p-channel transistors in a manner such that the source and drain terminals are interchangeable. Some aspects of the FET intrinsic time response are as yet unresolved, but a model which neglects the intrinsic time response has been successfully utilized in the SCEPTRE computer program to predict the transient response of a discrete MOS flip-flop circuit. (auth)

12732 HARDNESS OF A DIELECTRIC SWITCH TO IONIZING RADIATION. Bartko, J.; Sauvageto, Robert E. (Martin Marietta Corp., Baltimore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 217-20(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

The effect of transient and steady state radiation on a dielectric switch has been investigated. The dielectric switch is a solid state device which remains, indefinitely, in either a low resistance or a high resistance state. It trips from the former to the latter by the application of a high current pulse. The reverse procedure is accomplished by a high voltage pulse. For the transient study, pulses from a 55-MeV linac and 600-keV flash x rays were used. Gamma rays from a Co-60 source were used for the steady state study. The device appears impervious to a linac dose rate of 2.4×10^{10} rads(Si)/sec or an x-ray dose rate of 7.47×10^{7} rads(Si)/sec. Below a Co-60 dose of 8×10^{7} rads, negligible changes in resistance occur but above this level radiation induced switching (on-to-off) occurs as well as increases in resistance. The devices, however, recovered completely after the test was completed. Possible explanations for the responses are offered on the basis of a model developed for device operation. (auth)

12733 TUNNEL DIODE SWITCHING INDUCED BY TRANSIENT IONIZING RADIATION. Tobolski, J.; Chambers, E. S.; Kinder, J. D. (Douglas Aircraft Co., Santa Monica, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 221-2(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Radiation-induced switching in simple bistable tunnel diode circuits at radiation intensities in the range 10^{8}-10^{10} R/s was experimentally investigated at a 17-MeV LINAC source with 40-ns electron pulses. Silicon and gallium arsenide tunnel diodes (0.5-5 mA peak current) were operated at various levels below the peak point voltage and monitored for possible change of state following irradiation. Permissible low-voltage operating points for the bistable circuits where tunnel diodes did not switch to the high-voltage state were determined at several exposure rates. The results of the investigation have applicability in tunnel diode logic and memory array design. Tunnel diodes with higher peak-point currents (5 and 2 mA devices) were found to be more resistant to radiation-induced switching effects. Silicon devices were more consistent in response than gallium arsenide units. Silicon 4.8-mA tunnel diode circuits did not switch when initially biased at 73% peak current at a radiation exposure rate of 1.1×10^{9} R/s (44 R). (auth)

12734 PREDICTION OF INTEGRATED FLIP-FLOP CIRCUIT RADIATION VULNERABILITY. Chang, W. W.; Raymond, J. P. (Northrop Corp. Labs., Hawthorne, Calif.). Contract AF30(602)-3589. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 223-7(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

The ionizing radiation and neutron displacement damage failures of integrated flip-flop circuits are predicted from the electrical circuit parameters, geometry, and dominant radiation-induced failure mechanisms. The results are sufficiently accurate to guide an experimental study or a first-order vulnerability analysis. Techniques and approximations used are much simpler than the computer-aided circuit analysis usually required for the detailed determination of circuit response. Experimental and predicted radiation failure thresholds are presented for both a dielectrically isolated and a junction-isolated circuit. (auth)

12735 RADIATION-RESISTANT POWER CIRCUITS. Dickhaut, R. H.; Sayle, W. E.; Ingraham, C. N. (Boeing Co., Seattle). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 228-30(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Three radiation-hardened power circuits have been designed, fabricated, and tested. These semiconductor circuits, which typify functions found in advanced missile systems, are a high-voltage, 100-watt dc-to-dc converter, a 50-kHz, 10-watt modulator or chopper, and a 250-watt power switch. All circuits were specifically designed for extreme hardness to nuclear radiation environments and have been proven hard to 5×10^{11} rads(Si)/sec and neutron fluences up to 3×10^{14} n/cm^2 (E > 10 keV). (auth)

12736 RADIATION INDUCED SURFACE RECOMBINATION IN OXIDE PASSIVATED TRANSISTORS. Maier, R. J. (Naval Radiological Defense Lab., San Francisco). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 252-9(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Until very recently, the accumulation of positive charge has been reported as the dominant mechanism responsible for the surface effect in oxide passivated devices. A bipolar planar device with MOS field electrodes over each junction was investigated in the hope it would prove resistant to the surface effect. Some of the results of this investigation are presented in terms of models of the influence of the MOS field electrodes. The existence of the positive charge effect and the introduction of acceptor-like surface recombination states are demonstrated. The additional surface recombination states are shown to be the dominant mechanism. (auth)

12737 EFFECT OF ELECTRON IRRADIATION ON CARRIER MOBILITIES IN INVERSION LAYERS OF INSULATED GATE FIELD EFFECT TRANSISTORS. Stanley, Alan G. (Massachusetts Inst. of Tech., Lexington). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 266-75(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

The effect of 1.5 MeV and 20 keV electrons on the mobility was determined for a number of different types of n- and p-channel insulated gate field effect transistors with thermally grown oxide and deposited nitride passivation. An expression has been derived for the variation of the effective mobility with gate voltage as the result of surface scattering, which is in good agreement with values obtained from the channel conductance at 100 mV source to drain voltage. It is shown that the observed decrease in effective mobility after irradiation may be explained in terms of increased lattice scattering and Coulomb scattering by charged surface traps while the diffuse surface scattering remains unchanged. The channel conductance and transconductance of the devices were also measured in the saturation region. (auth)

12738 PROCESS TECHNIQUES AND RADIATION EFFECTS IN METAL-INSULATOR SEMICONDUCTOR STRUCTURES. Dennehy, W. J.; Holmes-Siedle, A. G.; Zaininger, K. H. (RCA Labs., Princeton, N. J.). Contract NAS5-10177. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 276-83 (Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

In the search for a means to minimize the radiation sensitivity of MOS transistors, a study was made on the interrelation between sensitivity to space radiation in MOS devices and the method of fabricating the gate oxide film of these devices. Both MOS capacitors and transistors were studied, using automatic plotting of capacitance-voltage and channel current gate voltage characteristics. For both types of device, the oxides studied were fabricated under varied but closely controlled conditions. Both special laboratory furnaces and production type of furnaces were used to grow the gate oxide. As a result of these experiments, the following conclusions were reached. Gate oxide process techniques vary in their effect on the sensitivity of MOS structures to high-energy radiation by an order of magnitude. The reproducibility of the degree of sensitivity to radiation is greater when steam-growth of oxides is used, rather than dry-oxygen growth. In general, the nearer the prebombardment C – V characteristic of an MIS insulator is to the ideal (charge-free) characteristic, the less sensitive is the MIS device to radiation. A key experiment was the successful hardening, by a factor of 2 to 3 in the voltage shift, of dry oxide layers by the addition of a coating of phosphorus containing glass. Several other process parameters (e.g. crystallographic orientation of the silicon) can be ruled out as to their influence on radiation sensitivity. The present levels of radiation sensitivity in mass-produced devices can be reduced by changes in process technique. (auth)

12739 IRRADIATION DAMAGE OF MOS-FETS OPERATING IN THE COMMON SOURCE MODE. Philipp, L. D. (Battelle Memorial Inst., Richland, Wash.); Lauritzen, P. O. Contract AT(45-1)-1830. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 284-92(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Thirty-three MOS-FETS were operated at various bias points under ^{60}Co gamma irradiation up to a total dose of approximately 10^7 R. The n-channel depletion, n-channel enhancement, and p-channel enhancement devices were operated at constant drain voltage in the common source mode. The results demonstrate effects of lateral oxide charge distributions along the channel between source and drain terminals. A tendency for the n-channel devices to gradually turn off is observed in addition to the threshold voltage shifts previously reported. A factor of ten improvement in radiation resistance can be obtained by using optimum device types (n-channel) at gate voltages which minimize threshold voltage shift (approximately zero volts). (auth)

12740 EFFECT OF ELECTRON RADIATION ON SILICON NITRIDE INSULATED GATE FIELD EFFECT TRANSISTORS. Newman, Phillip A. (Goddard Space Flight Center, Greenbelt, Md.); Wegener, H. A. R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 293-8(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Experiments indicate that silicon nitride passivation layers on top of thermally grown oxide in conjunction with heat treatment can improve the radiation stability of MISFET devices. In addition, MOSFET devices that have glass passivation layers and other special treatment can also show improved radiation stability. (auth)

12741 RADIATION INDUCED PEAKING EFFECT IN OPEN GEOMETRY P-CHANNEL MOSFETS. Newman, Phillip A.; Wannemacher, Harry E. (Goddard Space Flight Center, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 299-302(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

A shift in the gate threshold voltage of 7 to 9 times its initial value after irradiation with 2 to 6×10^{12} electrons/cm^2 of 1.5 MeV electrons is observed for a p-channel enhancement type MOSFET. The effect has only been observed at gate biases greater than −20 V. (auth)

12742 A NEW RADIATION-HARD MOS TRANSISTOR. Long, D. M.; Baer, R. (Martin Marietta Corp., Baltimore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 303-4(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

The oxide layer in the Sprague developmental TXF 200 p-enhancement MOSFET has been impregnated with phosphorus to increase the radiation stability. The transistor can tolerate more than 2×10^7 rads(Si) and 1×10^{15} n/cm^2 (E > 10 keV) without serious damage. Data are presented to illustrate the radiation stability. (W.H.K.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 12851, 12865, 12881, 12896, 12897, 12921, 12940, 12944, and 12948.

12743 (ACRH-1000-32) JUVENILE HYPERURICEMIA WITH NEUROLOGICAL MANIFESTATIONS. Sorensen, Leif B.; Moore, Robert Y. (Chicago Univ., Ill. Argonne Cancer Research Hospital, Chicago, Ill.). Sept. 1967. Contract AT(11-1)-69. 17p. (CONF-670941-2). Dep. CFSTI.

From 2nd International Congress on Neuro-Ophthalmology and Neuro-Genetics, Montreal, Canada.

Clinical and biochemical features in four boys (ages 6 to 13 years) from three families, suffering from a sex-linked neurological disorder associated with excessive purine synthesis are reported. The disorder of movement was manifested by both pyramidal and extrapyramidal involvement. Three patients exhibited the results of self-mutilation. The biochemical characteristics include a four to six-fold increase in uric acid production; a strikingly accentuated incorporation of glycine-^{14}C into urinary uric acid with an isotope pattern signifying the presence of a shunt pathway; and failure of azathioprine to suppress de novo biosynthesis. Allopurinol produced dramatic reduction in both plasma and urinary uric acid, but simultaneously on equivalent rise in the excretion of uric acid precursors. No significant derangement in urate metabolism was found in one asymptomatic carrier female. (auth)

12744 (BL-207) DNA METABOLISM IN TETRAHYMENA PYRIFORMIS. Brunk, Clifford F. (Stanford Univ., Calif. Biophysics Lab.). Sept. 1967. Contract AT(04-3)-326-7. 155p. Dep. CFSTI.

Thesis.

Contrary to the reports in the literature, no satellite density DNA component was found in DNA isolated from Tetrahymena pyriformis strain 6III, HSM, ST, or GL; all the DNA from a given strain had a single buoyant density in CsCl. Deoxyribonucleic acid prepared from isolated contamination-free mitochondria from these strains of Tetrahymena pyriformis had a density identical to that of the nuclear DNA from the respective strain. Attempts to demonstrate that this mitochondrial DNA exists as a covalently bonded twisted circle were unsuccessful. However, the relative utilization of ^{3}H-5-deoxybromouridine and ^{32}P in nuclear and mitochondrial DNA synthesis was shown to be different. This technique is suggested as a general procedure for detecting cytoplasmic DNA when density differences are not evident. The molecular weight of the isolated mitochondrial DNA was 30 to 40 $\times$ 10^{6} daltons. Ultraviolet and x ray induced damage in the DNA of Tetrahymena pyriformis appears to be repaired in the dark by an excision-repair system. An improved method for the detection of excision-repair is described, in which all of the DNA is replicated normally after being repaired. Repair synthesis is measured by the amount of post-irradiation label incorporated into the parental DNA strands. Characterization of the repair regions indicates that the average length of these regions is approximately 5000 nucleotides. The substitution of 5-deoxybromouridine for thymidine was found to be only one third as great during repair synthesis as during normal replication. Using this selection characteristic of repair synthesis, it was determined that repair synthesis is most active during the middle of the first generation after irradiation, but may persist for over a generation. (auth)

12745 (CONF-671120-1) A PROGRESS REPORT OF STUDIES CONCERNED WITH DAMAGE, REPAIR, AND RECOVERY IN THE PROLIFERATIVE CELLS OF THE MOUSE DUODENAL CRYPT FOLLOWING SINGLE-DOSE WHOLE-BODY IRRADIATION. Lesher, S.; Bauman, Janie (Argonne National Lab., Ill.). [1967]. 11p. Dep. CFSTI.

From 7th Annual Meeting of the American Society for Cell Biology, Denver, Colo.

Results are reported from a series of studies on damage, repair, and recovery in proliferative cells of the duodenal crypt in mice following external exposure to various doses of γ or x radiation. Data are presented on the effects of single and fractionated whole-body doses of γ and x radiation and fractionated doses of γ radiation on DNA synthesis, the duration of the cell cycle, and the sensitivity of various stages in the cell cycle. Results indicated that radiation doses from 150 to 1000 R induced a generalized reaction; most cells in mitosis at the time of exposure completed division, but the process was prolonged. Cells in G_2 were blocked for several hours and experienced difficulty with mitosis; the number going into m phase was dose dependent. With each complete cell cycle the unrepaired severely damaged cells were eliminated at mitosis. Eventually the crypt was repopulated with cells capable of repeated generation cycles, and the number of cells capable of mitosis and DNA synthesis increased rapidly at about 10 hr after exposure to 150 R, 16 hr after exposure to 300 R, and 60 hr after exposure to 1000 R. (C.H.)

12746 (EUR-3669) PREPARATION D'ACIDES RIBONUCLEIQUES MARQUES. RAPPORT FINAL. (Preparation of Labelled Ribonucleic Acids. Final Report). Ebel, J. P. (Strasbourg Univ. (France)). Dec. 1967. Contract 081-64-11 RISF. 12p. (In French). Dep.

Methods of preparation for structure study purposes of strongly labeled ribonucleic acids of various origins are reported: total, ribosomic or soluble RNA from micro-organisms (E. coli and yeast) or from animal tissue (nuclear or cytoplasmic RNA from various organs of rats and chickens). The radioactive precursors used were adenine, orotic acid or uracil, labeled with ^{14}C, ^{3}H, or ^{32}p-phosphate. Various methods of preparing these different types of RNA were studied and improved. The importance of a number of factors, such as the handling time and the use of ribonuclease inhibitors such as polyvinylsulphate, in all stages of preparation was shown. At the labeling doses obtained no radiolysis of the RNA was observed. (tr-auth)

12747 (ORNL-4094, pp 14-18) BIOCHEMICAL SEPARATIONS. (Oak Ridge National Lab., Tenn.).

Separation of about 1 g (total) of phenylalanine tRNA and leucine tRNA from the crude mixture of tRNA's produced from Escherichia coli cells was begun. In a series of runs, using coupled 1- and 0.4-in. chromatographic columns, the separation of phenylalanine tRNA and leucine tRNA was excellent; however, the phenylalanine product was unexpectedly contaminated by tryptophan tRNA. Another series of runs, made with coupled 2- and 1-in. columns gave much higher throughputs, equally good separation, and a product that was uncontaminated by tryptophan tRNA. Further experiments are now under way to process the remaining crude tRNA for isolation of the phenylalanine and leucine tRNA's. (auth)

12748 (ORNL-4171) THE MOLECULAR ANATOMY OF CELLS AND TISSUES (THE MAN PROGRAM). Annual Report, July 1, 1966-June 30, 1967. (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 139p. Dep. CFSTI.

The Molecular Anatomy (MAN) Program is concerned with the development of separation and analysis methods applicable to the problem of fractionating human cells, and of describing their structure at the molecular level. During the period July 1, 1966, to June 30, 1967, research and development efforts continued with emphasis on centrifugal separation methods. The K-IIA and K-IIB centrifuges were completed and evaluated in vaccine purification at length. The rotor is a continuous-flow-with-banding type with single-pass fluid-line seals at each end. Large quantities of purified influenza virus were prepared for mass field trials. Burst tests indicate additional developmental work should be done on the armor shield. Theoretical studies on the hydrodynamics of reorienting gradient rotors should allow the number of septa and the internal configuration of high-speed rotors of this type to be calculated. For s-p separations in which the isopycnic separation is accomplished in a gradient made of a slowly diffusing solute, a gradient-distributing rotor has been developed which allows 12 gradients to be made simultaneously in an angle-head rotor. A simple exponential gradient-forming device for use with the BXIV or BXV rotors was completed. The computer program for calculating equivalent sedimentation coefficients was updated and subroutines for data plotting included. Arrangements to produce density beads for isopycnic banding experiments were completed and batches of the beads tested. Equations relating gradient capacity to gradient slope have been verified experimentally. A variety of experimental studies are reported that include: separation of 7 and 18S hamster antibodies and the demonstration that antibodies to adenovirus 31 tumor antigens are in the 7S fraction; purification of quantities of Treponema pallidium; studies on the intracellular distribution of adenovirus 31 tumor antigens; development of a method for isolating rat liver cell membranes by a combination of rate and isopycnic zonal centrifugation in the same rotor; exploration of the application of s-p techniques to human brain and brain tumor subcellular particles; improvements in methods for centrifugal separation of macroglobulins both at low temperature

and at 30°C; evaluation of new titanium zonal rotors for human serum lipoprotein isolation; analysis of rat liver cell membrane lipids; and further exploration of gradient reorientation as applied to continuous-flow-with-banding rotors. Detailed information is presented on the application of the K-IIB centrifuge to the purification of five strains of influenza virus, using sucrose density gradients. A new technique for electrophoresis using a centrifugal field to stabilize the density gradient is presented. The use of an automated high-pressure liquid chromatographic system for the separation of ultraviolet absorbing constituents of human urine is continuing, together with the systematic analysis of the over 100 peaks observed. The problem of automating colorimetric analyses and enzyme assays was approached by developing a new technique for accurately measuring and quantitatively transferring small fluid volumes. Improvements were made in an automated system for total protein analysis. New methods for supporting samples for high-resolution electron microscopy have been developed and applied to myoglobin. The electron micrographs obtained show structures resembling the myoglobin molecule as deduced from x-ray diffraction studies, thus raising difficult problems in image interpretation. Special centrifuge tubes for sedimenting particles on electron microscope grids were developed and applied to the problem of virus counting below 10^5 particles per cm^3. (auth)

12749 (ORNL-P-3541) VARIATION WITH AGE OF ELEMENTAL CONCENTRATIONS IN HUMAN TISSUE. Tipton, Isabel H. (Tennessee Univ., Knoxville. Dept. of Physics. Oak Ridge National Lab., Tenn.); Johns, Judy C.; Boyd, Monica (Oak Ridge National Lab., Tenn.). July 1966. Contract W-7405-eng-26; Subcontract 2351. 18p. Dep. CFSTI.

To determine MPC values for various segments of the population it is desirable to take into account the possible variation with age of the concentration of an element in a tissue. Studies carried out on data for 173 subjects from the United States indicate a significant ($p < 0.001$) correlation with age of: aluminum in lung; calcium in aorta, rib, kidney, and testis; copper in cartilage and liver; magnesium in aorta, rib and vertebra; manganese in rib; phosphorus in aorta and testis; tin in lung. Since the values for the concentrations of these elements are found to be distributed log-normally (except those for calcium in rib which were normally distributed), equations for regression lines of the log of concentration on age (concentrations on age for calcium in rib) were determined and lines drawn with a 95% confidence interval. The concentrations of calcium, magnesium, and manganese in bone, and copper and manganese in liver are found to decrease; and the concentrations of calcium, magnesium, and phosphorus in aorta, calcium in kidney, and aluminum and tin in lung to increase with age. (auth)

12750 (RLO-1377-3) LYMPHOCYTE FORMATION, LIFE SPAN, FATE, AND POTENTIAL FOR REPOPULATING HEMOPOIETIC TISSUES OF IRRADIATED ANIMALS. Progress Report. [Everett, N. B.] (Washington Univ., Seattle). Dec. 12, 1967. Contract AT(45-1)-1377. 3p. Dep. CFSTI.

A colorimetric technique was developed for determining the number of circulating reticulocytes in irradiated rats. The method involves determining the RNA content of reticulocytes in a small volume of blood. It was found that the RNA values were proportional to the number of reticulocytes per unit volume of blood. Other studies were conducted on the origin of mononuclear leukocytes in inflammatory exudates of rats. Tritium-labeled thymidine was injected into bone marrow and coverslips were inserted subcutaneously into rats. The results showed that mononuclear cells of the bone marrow appeared early in the exudate fluid and by 12 to 18 hours some had transformed into macrophages. There was no evidence that small lymphocytes were involved. Studies on in vitro culturing of lymphocytes were continued. (H.L.W.)

12751 (NASA-TT-F-413) EFFECT OF SPACE-FLIGHT FACTORS ON FUNCTIONS OF THE CENTRAL NERVOUS SYSTEM. Livshits, N. N. (ed.). Translation of Vliyanie Faktorov Kosmicheskogo Poleta na Funktsii Tsentral'noi Nervnoi Sistemy, Izdatel'stvo Nauka, Moscow, 1966. 290p. CFSTI.

Separate abstracts were prepared for eight sections of this report. Nine additional chapters are included on the response of the nervous system to space-flight factors. (H.L.W.)

For abstracts of individual sections see: 12752–12759.

12752 (NASA-TT-F-413, pp 122-9) EFFECT OF ACUTE X-IRRADIATION ON VENOUS CIRCULATION IN THE CEREBRAL VESSELS OF A RABBIT. Klimovitskii, V. Ya. Translated from Vliyanie Faktorov Kosmicheskogo Poleta na Funktsii Tsentral'noi Nervnoi Sistemy, Izdatel'stvo Nauka, Moscow, 1966.

Cerebral venous blood flow was measured using thermistors for study of the cerebral surface veins of rabbits exposed to x radiation. In one group of animals the back and abdomen were irradiated by a dose of 2000 R. Other animals were exposed to total-body dose of 1000 R. In both cases a decrease in the level of cerebral blood flow was observed in the irradiated rabbits compared to the control during the first hours after irradiation. Locally irradiated animals were observed for six to eight hours. Whole-body irradiated rabbits survived after exposure and were observed until their death from radiation sickness. In these animals a second decrease of cerebral blood flow was observed one to two days prior to death. The data obtained are discussed in relation to data in the literature concerning the effect of irradiation on general and cerebral hemodynamics. (auth)

12753 (NASA-TT-F-413, pp 130-45) CHARACTERISTICS OF EFFECT OF DIFFERENT TYPES OF RADIATION ON THE HIGHER NERVOUS ACTIVITY OF SMALL ANIMALS. Korolevskii, A. P. Translated from Vliyanie Faktorov Kosmicheskogo Poleta na Funktsii Tsentral'noi Nervnoi Sistemy, Izdatel'stvo Nauka, Moscow, 1966.

The comparative effect of fast neutrons, 510 MeV protons, and gamma irradiation in a dose of 300 rad on the higher nervous activity of mice of the SS_{57}(Bl) strain was investigated, using the motor drinking conditioned reflex method. Exposure to these types of radiation induced disturbance of both excitation and inhibition. Neutron and gamma radiations led to more severe disruption of the excitation process, whereas proton radiation more seriously affected the inhibition process. With respect to effectiveness, the three types of radiation can be presented as follows: neutron > gamma radiation > protons. A parallelism was established between the dependence of disruption of conditioned reflex activity on linear ionization density. The changes in the indices of the peripheral blood cells are described. (auth)

12754 (NASA-TT-F-413, pp 146-57) CHARACTERISTICS OF EFFECT OF DIFFERENT TYPES OF RADIATION ON THE HIGHER NERVOUS ACTIVITY OF SMALL ANIMALS. Korolevskii, A. P. Translated from Vliyanie Faktorov Kosmicheskogo Poleta na Funktsii Tsentral'noi Nervnoi Sistemy, Izdatel'stvo Nauka, Moscow, 1966.

A study was made of the comparative effect of fast neutrons and gamma irradiation (^{60}Co) in a dose of 25 rad on the higher nervous activity of mice, employing the conditioned reflex drinking method. It is demonstrated that acute whole-body neutron and gamma irradiations reduced the degree of both inhibition and stimulation. Reduction of the processes of active inhibition and stimulation in mice exposed to neutron irradiation was expressed more clearly than in animals exposed to gamma irradiation. It was found that there is a parallelism between disruptions of conditioned reflex activity depending on linear ionization density, and changes in the hematological indices were observed. (auth)

12755 (NASA-TT-F-413, pp 158-74) CHARACTERISTICS OF EFFECT OF DIFFERENT TYPES OF RADIATION ON THE HIGHER NERVOUS ACTIVITY OF SMALL ANIMALS. Korolevskii, A. P. Translated from Vliyanie Faktorov Kosmicheskogo Poleta na Funktsii Tsentral'noi Nervnoi Sistemy, Izdatel'stvo Nauka, Moscow, 1966.

A study was made of the comparative effect of fast neutrons, and 510 MeV protons and gamma radiations in doses of 150 rad on the higher nervous activity of "August" rats. The motor drinking conditioned reflex method was used. Disturbances of excitation and inhibition processes were detected in all irradiated animals. Neutron and gamma irradiations resulted in greatest disruption of the excitation process, whereas proton irradiation caused greatest disruption of the inhibition process. Neutron irradiation was most effective, while proton irradiation was least effective. (auth)

12756 (NASA-TT-F-413, pp 175-91) COMPARISON OF THE EFFECT OF WHOLE-BODY CHRONIC AND ACUTE GAMMA IRRADIATION ON THE HIGHER NERVOUS ACTIVITY OF WHITE RATS (THE ROLE OF THE TIME FACTOR). Meyzerov, E. S. Translated from Vliyanie Faktorov Kosmicheskogo Poleta na Funktsii Tsentral'noi Nervnoi Sistemy, Izdatel'stvo Nauka, Moscow, 1966.

Two groups of rats were exposed to whole-body gamma irradiation by ^{60}Co in a dose of 160 R. One group was irradiated at a dose rate of 85 R/min and the other at the rate of 6 R/day. The conditioned motor alimentary reflexes and the cell count of the peripheral blood were studied in the rats. Acute and chronic irradiations caused similar changes in the conditioned reflexes. According to some data, the disturbances of higher nervous activity were somewhat more severe in rats exposed to chronic irradiation. Contrary to the reactions of higher nervous activity, the decrease of leukocytes, erythrocytes, and hemoglobin content in the peripheral blood was more sharply expressed in animals exposed to acute irradiation. (auth)

12757 (NASA-TT-F-413, pp 192-211) EFFECT OF CHRONIC GAMMA IRRADIATION ON FUNCTIONS OF THE VESTIBU-

LAR ANALYZER AND THE ROLE OF THE TIME FACTOR IN RADIATION REACTIONS OF THE NERVOUS SYSTEM. Apanasenko, Z. I. Translated from Vliyanie Faktorov Kosmicheskogo Poleta na Funktsii Tsentral'noi Nervnoi Sistemy, Izdatel'stvo Nauka, Moscow, 1966.

Male guinea pigs were exposed to prolonged gamma radiation with 500 R and a dose intensity of 0.6 R/min. The bioelectric activity of extensors of the rear extremity (hind leg) were investigated before, during, and after adequate stimulation of the vestibular analyzer. Survival rate, weight, and general clinical state of the animals also were studied. Prolonged irradiation induces strong and long-term changes of the electromyographic characteristics of the vestibular-tonic reflex for the muscles of the rear extremity. These changes are greater and qualitatively different from those induced by acute radiation in the same dose. All animals survived; the severity of radiation sickness and the changes in the peripheral blood are less than after acute irradiation. (auth)

12758 (NASA-TT-F-413, pp 212-28) COMBINED EFFECT OF DOUBLE EXPOSURE TO VIBRATION AND CHRONIC IRRADIATION ON THE FUNCTIONAL STATE OF THE VESTIBULAR APPARATUS. Apanasenko, Z. I. Translated from Vliyanie Faktorov Kosmicheskogo Poleta na Funktsii Tsentral'noi Nervnoi Sistemy, Izdatel'stvo Nauka, Moscow, 1966.

Guinea pigs were exposed to combined twofold vibration (15 min before and after irradiation) and prolonged gamma irradiation in a dose of 500 R and dose rate of 0.6 R/min. The bioelectric activity of the extensors of the rear extremities before, during, and after adequate stimulation of the vestibular analyzer was studied. The survival rate, number of leukocytes in the peripheral blood, weight, and general clinical state of the animals were investigated. The effect of vibration changes the radiation effects on the electromyographic characteristics of the vestibular-tonic reflexes. These changes were most significant during the first days after the exposure. However, the effects of prolonged irradiation are less affected by vibration than the similar effects of acute irradiation. The number of cells in the peripheral blood, weight dynamics, general clinical state, and survival rate of animals subjected to such combined exposure showed no statistically significant difference from the corresponding parameters for prolonged irradiation alone. (auth)

12759 (NASA-TT-F-413, pp 229-43) COMBINED EFFECT OF VIBRATION AND IONIZING RADIATIONS ON THE CONDITIONED REFLEXES OF RATS. Livshits, N. N.; Meyzerov, E. S. Translated from Vliyanie Faktorov Kosmicheskogo Poleta na Funktsii Tsentral'noi Nervnoi Sistemy, Izdatel'stvo Nauka, Moscow, 1966.

Groups of rats were exposed to: combined effect of whole-body vertical vibration at 70 cps and an amplitude of 0.4 mm for 15 min and immediately afterwards to total x radiation (50 R); effect of vibrostand noise for 15 min and then to total x radiation (50 rad); effect of vibrostand noise for 15 min (control). All exposures were repeated three times. The interval between the first and second exposures was 14 days and between the second and third was seven days. Experiments on rats exposed to vibration only were used for comparison. These were described in another paper by these same authors. Conditioned motor alimentary reflexes in rats were studied. In the first week after the first combined exposure the vibration effect dominated with respect to all indices. In the second week after the first exposure the combination of the effects of both factors was noted. After the second and third combined exposures the effects of irradiation and vibration were completely summed. (auth)

12760 (UCRL-Trans-10175) DISTRIBUTION AND FATE OF ^{86}Rb IN INBRED WISTAR RATS. Mabille, H.; Martin J.; Burg, C. Translated by Carol Holmes for Univ. of California Lawrence Radiation Lab., Livermore, from Compt. Rend. Soc. Biol., 155: 561-5(1961). 9p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The distribution of ^{86}Rb in the tissues of dogs, guinea pigs, mice, and rats was studied. Experiments on the metabolism of ^{86}Rb in white inbred Wistar rats were carried out under strict biological conditions. (C.H.)

12761 (UCRL-Trans-10179) THE URINARY EXCRETION OF ^{42}K AND ^{86}Rb BY THE GUINEA PIG. Mussa, G. C. Translated by J. I. M. Jones for Univ. of California Lawrence Radiation Lab., Livermore, from Minerva Pediat., 14: 623-6(1962). 10p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The difference in the urinary excretion of orally administered ^{86}Rb and ^{42}K was studied on guinea pigs of the same sex. The results show that the values for the ^{42}K eliminated in the urine in 24 hours, expressed as a percentage of the dose introduced, are approximately twice the values for ^{86}Rb. The results reported in the literature and those obtained in the present work indicate that the metabolic behavior of ^{86}Rb is very similar to that of ^{42}K, though the distributions in the various organs differ slightly. However, the greatest difference in the metabolic behavior of the two isotopes is the marked difference in their urinary excretion. (auth)

12762 MOVEMENT OF ^{22}Na, RADIOIODINATED PROTEIN, AND TRITIATED WATER FROM THE CISTERNA MAGNA INTO THE CEREBROVASCULAR CIRCULATION. Paulson, George; Kapp, John P. (Duke Medical Center, Durham, N. C.). J. Neurosurg., 27: 138-41(Aug. 1967).

The movement of ^{22}Na, ^{131}I-labeled albumin, and tritiated water from the cisterna magna into the sagittal sinus, vein of Labbe, and peripheral arterial blood was studied in monkeys. A different absorptive pattern was demonstrated for each material. Tritiated water appeared very rapidly in each of the three areas. Absorption of ^{22}Na was slower, and it appeared in highest concentration in cortical venous blood. Radioiodinated albumin, on the other hand, was probably absorbed in large degree via the draining system of the sagittal sinus. There was extremely rapid movement of HTO from the cisterna magna into the circulation. Within 10 min, the sagittal sinus, vein of Labbe, and arterial blood all contained similar amounts of radioactivity. Sodium-22, in contrast to tritiated water, met a partial barrier that prevented it from spreading quickly from the cerebrospinal fluid into the blood. This barrier was incomplete, however, and equilibrium was approximated after 45 min. Sodium-22 was not predominantly or solely absorbed by the vessels that drain into the sagittal sinus. It appeared that the major pathway of ^{22}Na absorption was via the brain tissue and cortical vessels rather than directly into the sagittal sinus. (BBB)

12763 THE EFFECT OF HIGH ENERGY RADIATION ON THE MITOTIC ACTIVITY AND RELATIVE BIOLOGICAL EFFECTIVENESS IN WALKER TUMORS. Voutilainen, A.; Rytila, A. (Univ. of Helsinki). Acta Pathol. Microbiol. Scand., 70: 285-90(1967).

Three-month-old CB stock rats received Walker cancer, implanted under the skin of the interscapular region, and irradiation was given 10 days later. The tumor dose was 300 rad and dose rate 40 rad/min. The radiation was given by 200 KV x rays, ^{60}Co γ rays, 32 MeV photons from a betatron, and both 20 MeV and 35 MeV electrons from the betatron. Irradiation was done at 7 pm and the animals were decapitated 12 hr after irradiation. Mitoses in tumor cells were counted per 100 fields over an area of 0.785 mm^2. The mitotic counts were highest in the control group and lowest in the 200 KV x ray group. The RBE values for the different irradiations ranged from 1 to 0.38, when the RBE of the 200 KV x rays was 1. The RBE of ^{60}Co γ radiation was 0.81 ± 0.19, of 20 MeV electron 0.48 ± 0.17, of 35 MeV electron 0.38 ± 0.20, and 32-MeV photons 0.61 ± 0.17. It appeared that different types of irradiation have different effects at different stages of the cell cycle. In the present work, 12 hr after the irradiation was the time chosen for examination. (BBB)

12764 RADIOSENSITIVITY OF VARIOUS PHASES OF THE CELL DIVISION CYCLE OF TUMOR CELLS. Schulz, K.-D.; Maass, H. (Univ., Hamburg). Arch. Gynaekol., 204: 53-4 (1967). (In German).

Irradiation of Ehrlich ascites mouse carcinoma tumor cells with doses of 500, 1000, 2000, or 5000 R of x irradiation produced complete inhibition of cell division, provided that the carcinoma was irradiated by the second day after transplantation. Irradiation of the tumor with these doses produced complete absence of mitoses. With a dose of 500 R mitoses resumed again within 7 hr after irradiation. With a dose of 2000 R the first mitoses were detectable after 28 hr. As shown by autoradiographs, the exceptional radiosensitivity, but entirely reversible inhibition of cell division, probably was related to blocking of the late G_2, or rest phase. Tests of radiosensitivity during the S phase by labeling studies indicated that if the tumor cells were irradiated during the S phase, very high irradiation doses (greater than 2000 R) were required to produce only partial inhibition of the DNA synthesis. If the tumor cells were irradiated during the early part of the S phase, then the irradiation inhibition effect on DNA synthesis was more marked. (BBB)

12765 STUDIES ON THE INDUCTION OF IMMUNOLOGIC UNRESPONSIVENESS. II. KINETICS. Golub, E. S.; Weigle, W. O. (Scripps Clinic and Research Foundation, La Jolla, Calif.). J. Immunol., 99: 624-8(Sept. 1967).

Kinetics of induction of immunologic unresponsiveness were studied after soluble human γ-globulin (HGG) was injected in mice to initiate the events leading to immunologic unresponsiveness, and spleen cells were removed at various times and transferred to immunologically inert (irradiated) recipients. The transferred cells were then challenged in this environment, which is free of extracellular antigen. Recipients were irradiated by whole-body x radiation in an 800 R dose 2 to 4 hr prior to cell transfer.

Mice were injected with either 0.5 or 5.0 mg soluble HGG. Daily after injection, spleens were removed and cell suspensions made of individual spleens. The washed cell suspensions were then injected into irradiated recipients, one spleen equivalent to one recipient. The recipients were challenged with HGG in adjuvant a few hours after transfer. One week later the immune status was evaluated by the rate of elimination of an injection of radioiodinated HGG. The results showed that cells were able to respond to the immunogenic form of HGG in the new host if they were transferred from the original animal at any time up to 4 days after soluble HGG injection. However, after 5 or more days the cells were unable to respond, indicating that there is an induction period of at least 4 days in the establishment of immunologic unresponsiveness. All animals that received cells which had been in the presence of soluble HGG for less than 4 days, but not longer, were able to respond to adjuvant HGG, even when they were challenged after the induction period was completed. (BBB)

12766 EFFECT OF ANAEROBIC CONDITIONS ON ABSORPTION AND DISTRIBUTION OF HEAVY WATER ($H_2{}^{18}O$) IN MAIZE AND SUNFLOWER PLANTS. Grinev, G. M.; Burkin, Z. S. (Timiryazev Inst. of Plant Physiology, Moscow). Sov. Plant Physiol. (Engl. Transl.), 13: 612-15(July-Aug. 1966).

Translated from Fiziol. Rasten., 13: 682-7(July-Aug. 1966).

The effect of root, atmospheric, and total anaerobiosis on absorption and distribution of heavy water in leaves was studied. It was noted that ^{18}O-labeled H_2O gave more reliable results than deuterated water (D_2O), which was harmful to tissues of the plants. The uptake of $H_2{}^{18}O$ from roots by both maize and sunflower leaves during a 6-hr period of total or atmospheric anaerobiosis was several times greater than in aerated plants. During root anaerobiosis, uptake was close to that of the controls or less. The enhanced flow of $H_2{}^{18}O$ into leaves under conditions of total or atmospheric anaerobiosis was an indication of disorganization of the plant's water regime, since it was associated with a drop in turgor that was a result of reduction of the leaves' water-retaining capacity. Evidently the inhibition of oxidative processes attendant on anaerobiosis disrupted the normal uptake and transport of $H_2{}^{18}O$. (BBB)

12767 THE PROPERTIES OF ^{90}Sr IN CHRONIC FEEDING STUDIES. PART II. Fingerhut, M.; Lang, K. (Johannes Gutenberg Univ., Mainz). Z. Ernaehrungswiss., 7: 87-97(1966). (In German).

Skeletal contamination with ^{90}Sr was related to its concentration in food fed to rats, as a function of time. Evidence for discrimination against ^{90}Sr in growing animals was presented. Discrimination against ^{90}Sr decreased in proportion to increasing age of the animals. The cumulative radiation doses received from deposited ^{90}Sr as a function of age were evaluated from mathematical functions developed from the results of the chronic feeding studies. Comparison of these results with known biological effects of ^{90}Sr indicated that they exceeded safe limits by a factor of ~3. (BBB)

12768 NERVOUS AND HORMONAL CONTROL OF THE STRUCTURE AND ^{131}I UPTAKE BY THE SUBMAXILLARIES. Houssay, Alberto B. (Univ., Buenos Aires). Ala. J. Med. Sci., 3: 312-24(July 1966).

A comparative study was made of the effects of nervous and endocrine factors on the ^{131}I uptake by the submaxillary glands in mice, rats, and hamsters. A sex difference in the submaxillary ^{131}I uptake (greater uptake in males) was found in A_2G mice and in hamsters. In both species castration decreased the submaxillary ^{131}I uptake in males, but did not change it in females. Administration of testosterone propionate increased ^{131}I uptake by the submaxillaries in castrated male or female A_2G mice and hamsters. Administration of estradiol benzoate or dipropionate did not change ^{131}I uptake by submaxillaries in castrated male or female A_2G mice. Radiothyroidectomy (with 150 μCi of ^{131}I) decreased the ^{131}I uptake by the submaxillaries in male A_2G mice, but did not change it in females. The parallel between the effect of the gonads and the thyroid upon the size of the serous tubules of the submaxillaries and their effect upon the ^{131}I uptake by these glands was stressed. Adrenalectomy increased ^{131}I uptake by the submaxillaries in male A_2G mice. Administration of cortisone acetate decreased ^{131}I uptake by the submaxillaries in adrenalectomized male A_2G mice aldosterone did not change it. The effect of adrenal glucocorticoids upon the submaxillary ^{131}I uptake was different from its effect upon the serous tubules of the gland. In the hypertrophic submaxillary glands, induced by repeated incisor amputations, ^{131}I uptake underwent no change. This was explained by the fact that the serous tubules of the gland, apparently the site of the ^{131}I uptake, were not hypertrophied. (BBB)

12769 ANTAGONISTS OF DNA SYNTHESIS IN CORNEAL EPITHELIAL CELLS OF THE DOGFISH. Zigman, Seymour; Tuttle, Joan; Lerman, Sidney (Univ. of Rochester, N. Y.). Invest. Ophthalmol., 5: 636-9(Dec. 1966).

Effects of iododeoxyuridine (IUDR) and uv and γ radiation (^{137}Cs) on the synthesis in vitro of DNA by corneal epithelial cells of the dogfish were examined. Thymidine-^3H uptake was depressed to 50% of the control value by the addition of 10^{-4}M IUDR. When the concentration of IUDR was equivalent to that of thymidine (10^{-3}M), incorporation of thymidine was maximally depressed to <25% of the control values. When ^{125}I-UDR (10^{-5}M) was substituted for thymidine in the incubation mixture, 7% of the DNA thymidine was replaced by IUDR as measured by isotopic incorporation. Maximum inhibition (to 50% of the control values) occurred following exposure to uv radiation. Uptake of thymidine into γ-irradiated cells was maximally inhibited by 3000-R exposure, resulting in a decrease to 50% of the control values. Ultracentrifugation patterns of DNA from the control and the irradiated samples were shown. The uv irradiation appeared to be more effective in breaking the DNA chains than γ irradiation on the basis of sedimentation rate and reaction to heating with formaldehyde. Ultraviolet absorption and ultracentrifugation studies suggested that both forms of irradiation exerted their effects by breaking DNA chains. Heating the irradiated samples with formaldehyde gave much less of a hyperchromic effect than the control samples, indicating an altered DNA from the irradiated cells that could no longer be denatured as could native DNA. Further evidence for the breakage of DNA chains after irradiation was the lower sedimentation rates of the irradiated DNA. (BBB)

12770 THE SITE OF IODIDE CONCENTRATION IN HAMSTER SALIVARY GLANDS AS DEMONSTRATED BY AUTORADIOGRAPHY. McGee, J. O'D.; Mason, D. K.; Duguid, W. P. (Royal Infirmary, Glasgow). Arch. Oral Biol., 12: 1189-93 (Oct. 1967).

Radioiodine localization was studied in hamster salivary glands using a method based upon the principle of keeping the tissue and tissue fluid within it solidly frozen from the time of removal from the intact animal until exposure to the autoradiographic emulsion was completed. The animals received 500 μCi of ^{131}I intraperitoneally. One hr later, under ether anaesthesia the submaxillary and sublingual glands were dissected out and immediately placed in a freezing mixture of solid carbon dioxide and butanol. Autoradiography was carried out at low temperatures also. The areas within and around the proximal ducts of the submaxillary gland showed a marked concentration of ^{131}I. The surrounding acinar tissue, distal ducts, and adjacent blood vessels showed only slightly above-background levels. A few larger distal interlobular ducts showed a more intense radioactivity than the remainder. There was negligible ^{131}I concentration by the ducts or acini of the hamster sublingual gland although a few of the large excretory ducts showed some radioactivity. These autoradiographic studied provide further evidence of a ductal site of radioiodide transfer in salivary glands using a new approach to tissue-emulsion contact. (BBB)

12771 ADRENAL CORTEX AND HOMEOSTATIC REACTIONS INVOLVED IN THE FORMATION OF ANTIBODIES UNDER THE ACTION OF IONIZING RADIATIONS. Benetato, Gr.; Schiau, S.; Petrescu, D.; Boros, I.; Stoenescu, R.; Ghizari, Eugenia; Strungaru, Alexandra (Institutul de Fiziologie Normala si Patologica Daniel Danielopolu, Bucharest). Fiziol. Norm. Patol. (Bucharest), 11: 493-500(1965). (In Rumanian).

The literature (61 references), including many of the authors' earlier reports, is reviewed with regard to the role of adrenal cortical secretions and other homeostatic mechanisms in antibody synthesis in irradiated animals. The negative feedback concept of antigen-antibody interrelations and control of antibody formation was explained. This system was then discussed in terms of the catabolic or antianabolic action of corticosteroid hormones and its significance on plasma protein and antibody synthesis. Recent experiments at the Institute for Physiology of the Rumanian Academy showed that in the sera of irradiated animals certain factors that activate the immune response appeared. Previous experiments showed that the general inhibitory effect of irradiation on the production of antibodies tended to be compensated by the activity of the adrenal cortex. On the basis of the data discussed, it was concluded that the direct inhibitory effect of ionizing radiation on antibody-forming cells was attenuated by other reactions, among which was that of the adrenal cortex, as an effect of irradiation. (BBB)

12772 EFFECT OF IRRADIATION BY IONIZING RADIATION ON MILK ENZYMES. I. PRELIMINARY EXPERIMENTS AND IRRADIATION EFFECTS ON PHOSPHATASE ACTIVITIES IN MILK. Tsugo, Tomokichi; Hayashi, Toshio (Tokyo Univ.). Nippon Chikusangaku Kaiho, 32: 301-7(Dec. 1961). (In Japanese).

Milk was irradiated with 180-KV x rays and ^{60}Co γ rays. Bacterial counts by the plate method reached zero after 26-KR x irradiation under aerobic conditions and the survival curve of bacteria was exponential in shape with increasing doses of x rays. Flavor

changes in whole milk from ionizing irradiation were smaller than those in skim milk and the off-flavor produced was an oxidized fat flavor. It was suggested that the fat of whole milk acted as a protective substance for the other milk constituents. Changes in pH value and acidity of skim milk were more unstable than those of whole milk and the off-flavor produced was a decomposed protein flavor. The effects of irradiation on milk phosphatase were also examined. Phosphatase in milk showed a great radiation resistance. Its activity was reduced only about 5% after 880-KR irradiation and by about 70% after 21-MR irradiation. It was confirmed that no positive phosphatase tests after high-dose irradiation were caused by phosphatase-positive compounds (e.g., phenolic compounds) which might have been produced by the decomposition of milk protein due to such high-dose irradiation. Milk phosphatase was very sensitive to heat treatment in spite of its great radiation resistance. Skim-milk phosphatase had a shorter lag-phase of irradiation inactivation than whole-milk phosphatase. Skim-milk phosphatase began to lose its activity at a lower dose than whole-milk phosphatase. (BBB)

12773 PHAGOCYTOSIS OF COLLOIDAL GOLD (^{198}Au) AND ^{51}Cr-LABELED ENDOTOXIN IN RABBITS. Haugen, Jostein (Univ. of Bergen). Acta Pathol. Microbiol. Scand., Suppl., 187: 38(1967).

The phagocytosis of colloidal ^{198}Au was studied and the clearance rate was expressed by the phagocytic index K. The K value varied according to the amount of ^{198}Au injected, but was relatively constant and reproducible in normal rabbits injected with the same amount of ^{198}Au. No sex difference was found. Thorium dioxide (Thorotrast)-treated rabbits had a significantly lower K value for ^{198}Au than normal rabbits. The K value of ethyl palmitate-treated rabbits did not differ from that of Thorotrast-treated rabbits. The K value of rabbits made tolerant to endotoxin was slightly higher than in normal rabbits. Electron microscopic studies revealed the ^{198}Au particles in the lysosomes of Kupffer cells in normal rabbits. In Thorotrast-treated rabbits ^{198}Au and ThO_2 particles were located both in the lysosomes and pericapillary space. The ^{198}Au test seemed sensitive to changes of the phagocytic activity, and was used for measuring the effect of certain drugs on the phagocytosis of particles. The phagocytosis of endotoxin, probably due to another mechanism, was also measured by use of ^{51}Cr-labeled lipopolysaccharide from Salmonella. The phagocytic index K was relatively constant in normal rabbits, and in Thorotrast-treated rabbits K was equal to that of normal rabbits. (BBB)

12774 EFFECT OF DIETARY CALCIUM ON THE ABSORPTION AND RETENTION OF RADIOSTRONTIUM. Nordin, B. E. C.; Smith, D. A.; Shimmins, J.; Oxby, C. (General Infirmary, Leeds, Eng.). Clin. Sci., 32: 39-48(Feb. 1967).

Small oral doses of ^{85}Sr (0.25 μCi, as $SrCl_2$) were administered twice daily for several weeks to 32 patients under investigation for disorders of Ca metabolism. Fecal radioactivity ranged from 31.8 to 100.5% of the daily administered dose and was positively related to the Ca intake. Urinary radioactivity ranged from 0.5 to 34.5% of the daily administered dose and was negatively related to the Ca intake. Owing to the opposite effect of dietary Ca on fecal and urinary excretion of radiostrontium, Ca supplimentation did not significantly affect radiostrontium retention. The ratio of radiostrontium to stable Ca in the urine was higher than the corresponding ratio in the plasma by a factor of about three. The ratio of radiostrontium to stable Ca in the plasma was lower than the corresponding ratio in the diet, the difference depending on the Ca balance. At high Ca intakes the plasma ratio approached 0.6 of the dietary ratio, but at low Ca intakes the difference between the plasma and dietary ratios was much greater. (BBB)

12775 ^{90}Sr METABOLISM IN MAN. Samachson, Joseph; Spencer, Herta (Veterans Administration Hospital, Hines, Ill.). Israel J. Med. Sci., 3: 691-6(Sept.-Oct. 1967).

By use of low-level counting methods, ^{90}Sr metabolism was studied in healthy young adults and in older ambulatory patients on both low and high Ca diets. Net ^{90}Sr absorption, calculated from the difference between the amounts ingested with food and that found in stool, was 15 and 12% respectively, for the younger and older groups who received a low Ca diet, and 16 and 6%, respectively, for the younger and older groups who received supplementary Ca. The younger group received Ca in milk, the older group in Ca gluconate tablets. None of these values differed significantly from each other. There was no correlation between average ^{90}Sr absorption in the different groups although the young adults who received milk showed both a high Ca and a relatively high ^{90}Sr absorption that could be at least partly ascribed to an increased amount of ^{90}Sr in the diet. This group showed the only positive balance for ^{90}Sr. All four groups showed a positive correlation between urinary ^{90}Sr excretion and urinary Ca excretion. The observed ratio for stool/diet was greatly superior to the observed ratio for urine/diet in estimating both the ^{90}Sr/Ca ratio in the original diet and the total dietary intake of ^{90}Sr. (BBB)

12776 MIGRATION AND DISPERSAL PATTERNS OF ^{59}Fe-LABELED LONE STAR TICKS. Smittle, B. J. (Dept. of Agriculture, Gainesville, Fla.); Hill, S. O.; Philips, F. M. J. Econ. Entomol., 60: 1029-31(Aug. 1967).

Methods for labeling ticks (Amblyomma americanum) with ^{59}Fe, handling of the radioactive insects, and use of them in field dispersal studies are presented. About 16,000 ticks (8000 unengorged adults and 8000 unengorged nymphs) were externally labeled with ^{59}Fe by a Büchner funnel dipping technique; 10 ml of a solution of ^{59}Fe (ferrous citrate, specific activity of 10 pCi/ml) was applied to each group of 100 adults or 200 nymphs. In the procedure described the ticks were placed in a Büchner funnel and exposed to the solution by pouring the liquid over them. One minute later, the excess liquid was drawn by suction into a vacuum flask beneath the funnel. The same procedure was repeated eight times with each group of ticks; the same solution was used each time. Then the ticks were removed from the funnel, placed on absorbent paper, and collected in a test tube by a vacuum apparatus. When the ticks were released in the field, the average cpm value (above background) was 213 for the females, 121 for the males (combined average for adults = 175), and 54 for the nymphs. Later the specific activity of the ^{59}Fe solution was increased from 10 to 20 μCi/ml, and the average count/min above background of the ticks collected 72 hr after release was 216 for the males and 546 for the females, a combined average of 381/adult. After they were released 25 ft from shaded areas at four sites, the predominant direction of migration was toward and into the shaded areas. The ticks migrated as much as 75 ft in 72 hr and a total of 95 ft in 11 to 12 weeks. (BBB)

12777 ON THE LOCALIZATION OF ^{131}I AND $^{35}SCN^-$ IN THE THYROID, PAROTID, AND SUBMAXILLARY GLANDS OF GUINEA PIGS, STUDIED WITH THE AID OF FROZEN-SECTION AUTORADIOGRAPHY. Kleine, Tilmann O. (Univ., Heidelberg). Arch. Pharmakol. Exp. Pathol., 258: 215-28(Sept. 15, 1967). (In German).

Five hr after intraperitoneal injection of radioiodine in the guinea pig, autoradiography of frozen sections revealed ^{131}I deposition particularly in the periphery of follicle lumen of the thyroid gland, and less ^{131}I above the marginal zone of the follicle, follicle cells, and interstitial connective tissue. Four hr after injection of ^{35}S-labeled thiocyanate, film grains were found above the interstitial connective tissue (capillaries), follicle cells, and marginal zone of the thyroid follicle, with fewer seen in the lumen of the follicles. The number of silver grains above the follicle cells was greater than above the marginal zone and the lumen of follicles. An appreciable concentration of ^{35}SCN in the thyroid follicle was not seen. These results are discussed in terms of a 4-compartment model of ^{131}I thyroid uptake. In the same manner radioiodine and ^{35}S-labeled thiocyanate were studied in the parotid and submaxillary glands of the guinea pig. They were deposited in the acini in the cytoplasm of the cells, in the smallest proximal ducts, as well as in the lumen of larger excretory ducts. Concentration of both anions was seen in the small proximal excretory ducts, especially peri- and intraepithelially in the cytoplasm, and less in the lumen. The results are discussed with regard to the secretion and concentration mechanisms of both anions in guinea pig saliva. (BBB)

12778 MEAN TRANSIT TIME OF A NONDIFFUSIBLE INDICATOR AS AN INDEX OF REGIONAL CEREBRAL BLOOD FLOW: AN EXPERIMENTAL STUDY IN MAN WITH ALBUMIN-^{131}I AND ^{85}Kr. Fieschi, Cesare; Agnoli, Alessandro; Battistini, Noe; Bozzao, Luigi. Trans. Amer. Neurol. Ass., 91: 224-6 (1966).

Expressions are derived for determining regional cerebral blood flow (RCBF) by recording the build-up and subsequent clearance in the brain of a biologically inert radioactive diffusible indicator injected as a bolus into an afferent artery (^{85}Kr). In the same region, the passage of a bolus of a nondiffusible indicator (such as radioalbumin-^{131}I (RISA) can be recorded to obtain from the transit curve an index of CBF. Relations between these two techniques for estimating the same variable, CBF, are discussed and experimental data presented showing to what extent the mean transit time of radioalbumin is related to CBF. Some isotopes with similar peaks of energy of γ emission (^{85}Kr = 0.562 MeV, ^{131}I = 0.364 MeV) were used; it was assumed that the same region was being studied with both tracers. In 24 subjects (8 normals and 19 patients with cerebral vascular lesions), by cannulation of the internal carotid artery, a bolus of ^{85}Kr (3 ml, sp act. 1 mCi/ml) was injected, and the build-up and subsequent clearance of radioactivity recorded by a scintillation detector collimated over

the ipsilateral parietotemporal region. Regional cerebral blood flow values ranging from 14 to 53 ml/100 g/min were obtained in the 27 subjects. After the clearance of ^{85}Kr, a bolus of 40 μCi of ^{131}I-RISA was rapidly injected, and the passage of radioactivity in the cerebral vessels was recorded by the same detector. It was concluded that the regional mean transit time of RISA is a linear, even if approximate index of regional cerebral blood flow, and can be used with that meaning for comparison between normals and patients with cerebral vascular lesions. In studying the changes of RCBF induced by different physiological conditions or by pharmacological stimuli, the variations of blood flow may be underestimated by the mean transit time of nondiffusible indicators due to simultaneous changes of the brain blood pool. (BBB)

12779 RADIOTOXICOLOGIC ASPECTS OF RADIOACTIVE CONTAMINATION. **Furnica, G.; Racaveanu, N. (Institutul de Igiena, Bucharest). Igiena (Bucharest), 15: 577-87 (Oct. 1966). (In Rumanian).**

Metabolism of natural and artificial radionuclides that may be present in the human environment is reviewed. That of ^{137}Cs is examined in detail. It is absorbed rapidly from the gastrointestinal tract, diffuses into extracellular fluid, and replaces K in muscle. It is gradually exchanged for K and excreted but because of a long half life residual deposits may produce internal irradiation for an extended period. Some methods for determination of radionuclides in body fluids and tissues are outlined. Disintegration schemes of Ra are explained in terms of hazards of the various daughter products. Mathematical expressions are provided for calculation of the doses of internal irradiation for various radionuclides. (BBB)

12780 USE OF THOROTRAST. **Granger, Gordon A. (Fellows Medical Manufacturing Co., Detroit). Brit. Med. J., 2: 112 (Oct. 14, 1967).**

Thorotrast is the subject of an approved new drug application under the provisions of the U.S. Food, Drug, and Cosmetic Act. Thus, the Food and Drug Administration has approved the drug for use by the medical profession in the U.S. only under certain limited conditions, under which it is safe and effective. The label, labeling, and sales agreement, that must accompany this product when sold in the U.S., set forth in detail the conditions of use which the Food and Drug Administration has approved for the drug. The authorized uses are closely restricted and the product may be administered only under the supervision of certified radiologists. A recent report (ibid., 2: 206(July 22, 1967)), indicated that Thorotrast may be used for conditions other than those specified. Such use is unauthorized in the U.S. and could seriously jeopardize the health and welfare of persons to whom it is administered. The drug must be used only in those conditions where the life expectancy is definitely short. Thorotrast can be used to follow the effects of chemotherapeutic agents in malignant diseases of the liver and malignant cysts of the brain, and no other uses have been authorized. (BBB)

12781 MINERAL NUTRITION OF PLANTS. **Bollard, E. G. (Dept. of Scientific and Industrial Research, Auckland, N. Z.); Butler, G. W. Annu. Rev. Plant Physiol., 17: 77-112 (1966).**

A review is presented of the accumulation and metabolism of what are considered the nonessential, or (functional) elements in plant nutrition. These are nutrients that may function in some precise way though not specific or indispensable. Included in the review is a discussion of those plants that deviate from the normal proportions of nutrients; those that tolerate normally adverse mineral conditions, and those that accumulate nutrients in excess of environmental proportions. With regards to the nutrition of the lower plant forms, the nonessential elements discussed include: the alkali elements (lithium, sodium, rubidium, and cesium), the alkaline earth elements beryllium, calcium, strontium, and barium), the halogen elements (bromine, fluorine, and iodine), and other elements including selenium, silicon, aluminium, and cobalt. The adaptation of plants to unfavorable mineral environments is discussed in terms of saline conditions, soil pH and heavy metal tolerance. Here again the lower plant forms only are considered. The nonessentiality of an element does not necessarily preclude it as an influential factor in the metabolism of a plant. It may, in fact, effect the plant's metabolism in one of several ways: by influencing reaction rates, by replacing an essential element in a normal reaction, or by undergoing a specific reaction itself. Each of these possibilities is discussed, and examples are included in the text. (E.R.B.)

12782 PHYSIOLOGY OF ROOT GROWTH. **Street, H. E. (University Coll. of Swansea, Wales). Annu. Rev. Plant Physiol., 17: 315-44(1966).**

A review is presented of the research being conducted on the physiological mechanisms of root growth. Evidence from a variety of sources suggests that root growth is a consequence of the functioning of apical meristems, the initiation of new meristems in the pericycle leading to lateral root emergence and growth, and the development and functioning of vascular and cork cambium. The use of irradiation studies and tracer techniques has figured prominantly in the amassing of evidence regarding the physiological mechanisms involved in root growth. The roles of the nucleus, RNA, and protein synthesis, and auxins in this phenomenon are reviewed. The review reflects the increased awareness of the role of boron in root growth. Special consideration is given to the differentiation of root hairs and the initiation of lateral roots. Studies of the effects of ionizing radiation on the latter have elucidated many of the mechanisms involved. Attention is also given in the review to the initiation and functioning of the vascular cambium, the root-shoot relation, and the release of organic metabolites by the growing root. (E.R.B.)

12783 EFFECTS OF LASER RADIATION ON SUBCELLULAR COMPONENTS. **Malt, Ronald A. (Massachusetts General Hospital, Boston). Fed. Proc., 24: Transl. Suppl. 14, 122-5 (Jan.-Feb. 1965).**

Effects of He–Ne and ruby laser radiation, focused by lenses to give target diameters as small as 1.5 μ, on cell organelles were studied. Directed to the animal (black) pole of frog eggs or to the limb buds of embryos, the beams produced inconsistent growth disturbances. Lesions 15 to 24 μ in diameter were produced in cell walls of alga stained with methylene blue by a pulse of 0.16 mJ. Chloroplasts and nuclei were separately damaged by larger pulses. Inhomogeneity of the laser beams employed and imperfections in the optical systems prevented a closer approach to the theoretical limit than a spot of dia 1 μ. Transparent media irradiated by this light were little affected unless they were indiscriminately fulgurated. Naturally colored objects or those artificially pigmented with vital dyes or carbon particles absorbed a specific spectrum of incident light and were individually injured by less intense rays. Parts of erythrocytes, whole mitochondria, sites of phagocytosis and pinocytosis, and melanotic granules were selectively destroyed. (BBB)

12784 LASER: DEVELOPMENT AND USES. **Maddock, Gene E. (Harper Hospital, Detroit). Harper Hosp. Bull., 24: 238-42 (Sept.-Oct. 1966).**

Biological and medical studies utilizing lasers are briefly reviewed. In the skin of Syrian hamsters exposed to single pulses of laser radiation of 30 and 50 J the immediate effect appeared similar to second degree thermal burns. The irradiated sites underwent complete recovery. In the laser-irradiated skin of albino and pigmented rabbits, and of Caucasian and Negro volunteers, there was a more intense reaction, in the form of inflammatory change, in the skin with darker pigmentation. Light-colored tissue appeared to reflect and transmit the beam with little evidence of physical change. Fresh preparations of epidermis, mucosa, and HeLa cells showed no effect from exposure to a laser beam, but following vital staining with Evans blue and other dyes the cell bodies showed disintegation or vacuolization. In blood smears the red cells were destroyed while the white cells were variably affected. Thus coloring, either natural or artificial, increased the ability of the laser to destroy cellular material. Hence, cells containing hemoglobin or melanin tended to undergo the most change. When fibrosarcomas and cancers of the thyroid were treated with laser exposure, the fibrosarcomas showed 60 to 80% destruction. The thyroid tumors disappeared, both grossly and microscopically. Effects of laser radiation on the eye and precautions that must be observed with laser use are also considered. (BBB)

12785 IMMUNOLOGIC REACTIONS AND CANCERS. ATTEMPTS AT IMMUNOTHERAPY. **Mathe, G. (Institut Gustave Roussy, Villejuif, France). Cah. Coll. Med., 7: 677-82 (1966). (In French).**

The possibility of immunization against cancer by various means including use of whole-body irradiation and bone marrow grafts is discussed. The questions as to whether cancerous cells lack normal antigens and as to whether there are specific antibodies against cancer are discussed. The mechanisms whereby antibodies act against cancer cells are also discussed. Irradiation, when applied to newborn animals, was effective in inducing tumors, and as other carcinogenic substances, led to production of antitumor antibodies. Immunologic processes after growth of radioinduced tumors are described. Three types of antineoplastic immunotherapy are discussed: passive, active, and adoptive. Adoptive immunotherapy, such as that which occurs after irradiation, produces a long-term effect on tissue as well as a short-term one. Whole-body irradiation with a 1000-R dose, in leukemia, not only destroys radiosensitive cancerous cells but also permits bone marrow grafting that may inhibit future leukemogenesis. Use of

irradiation and bone marrow transplantation to treat leukemia in laboratory animals and man is discussed. (BBB)

12786 SOME FUNDAMENTAL CONCEPTS IN RADIATION BIOLOGY. West, Howard J. (Harper Hospital, Detroit). Harper Hosp. Bull., 24: 225-32(Sept.-Oct, 1966).

Some current concepts in radiobiology are considered under two main headings: effect of ionizing radiation on the individual cell and then on the human organism as a whole. The two principal radiochemical effects that have significance in cell survival, i.e., the ionization of water and the direct action of radiation on the cell, are discussed. Also considered are LET and several environmental factors important in altering cellular radiosensitivity, including pH, temperature, water content, and oxygen content. Other topics discussed are: variations in radiosensitivity of normal tissue and tumors, effects of radiation on skin, and therapeutic application of radiobiological principles. (BBB) (TSS)

12787 COMBINED EFFECTS OF COMPLEX FORMING SUBSTANCES AND DIURETICS ON THE BEHAVIOR OF RADIO-EMITTERS IN THE ORGANISM. Tregubenko, I. P.; Semenov, D. I. Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial, No. 46, 147-9(1966). (In Russian).

The effects of mixtures of sodium ethylene diaminetetraacetate (EDTA) and sodium hexametaphosphate (HMP) diuretics (diuretin, methyl coffeine and mercusol), or adrenalin on the behavior of ^{144}Ce, ^{239}Pu, or ^{91}Y in rats was studied. Statistical data indicated a considerable difference in the effects of EDTA and HMP. Combined applications of EDTA and HMP produced a less pronounced effect than EDTA alone. Diuretics did not influence the behavior and excretion of Ce, Pu, and Y. EDTA or EDTA combined with methyl coffeine inhibited Ce deposition in the skeleton, mercusol combined with HMP enhanced deposition of Pu in the liver. Adrenalin alone or combined with EDTA and HMP increased slightly the deposition of Y in the liver. (R.V.J.)

12788 CHROMATOGRAPHY OF PRODUCTS OF IRRADIATED ERGOSTEROL. PART I. ADSORPTION CURVES OF ERGOSTEROL, VITAMIN D_2, AND THEIR ESTERS ON OXIDES OF ALUMINIUM AND SILICON. Tulecki, Jerzy; Adamczewska, Zofia (Medical Academy, Poznan, Poland). Poznan. Tow. Przyj. Nauk, Wydzial Lek., Pr. Kom. Farm., 1: 27-34(1961). (In Polish).

Methods were developed for isolation and identification of some of the products of the action of uv radiation on ergosterol. Separation of uv-induced photolysis products by the chromatographic column method has not yet been fully accomplished, although some degree of separation of mixtures has been obtained: precalciferol$_2$ + luminsterol$_2$ + suprasterol$_2$ II, calciferol + tachysterol$_2$ + suprasterol$_2$, and ergosterol + isopyrocalciferol$_2$. An investigation was made of the effect of water on the adsorptive power of aluminium oxide and activated silica, on the assumption that differences in the absorption of compounds with sterol and nonsterol groups should occur. The experimental results led to the conclusion that the addition of 1, 3, or 5% of water to the adsorbents reduces the adsorptive action of aluminium oxide and silica, considerably augmenting the difference in their adsorptive action on ergosterol and ergosterol 3,5-dinitrobenzoate on the one hand, and vitamin D_2 and vitamin D_2 3,5-dinitrobenzoate on the other. The results indicated that the chromatographic column could be used for separating products of uv photolysis on active aluminum oxide and silica containing an appropriate amount of water. (BBB)

12789 EFFECT OF IONIZING RADIATIONS ON THE MOBILIZATION OF FREE FATTY ACIDS. Berti, F.; Usardi, M. M. (Univ., Milan). Boll. Soc. Ital. Biol. Sper., 41: 392-5(Apr. 30, 1965). (In Italian).

The liberation of free fatty acids (FFA) in vitro from epididymal fat tissue was studied in tissue from irradiated rats, incubated under basal conditions and with stimulation of postganglionic sympathetic nerve fibers. Some of the Sprague-Dawley rats used were submitted to bilateral adrenal medullectomy 20 days before the experiments, and some were injected with reserpine (5 mg/Kg, intraperitoneally) at 24 and 6 hr before the experiments. Other rats received both preliminary treatments. All were subjected to 3000-R whole-body x irradiation. Plasma glucose and FFA levels were then determined, and the epididymis removed along with its connecting blood vessels and nerves. This tissue was incubated in Ringer's solution, while the nerves were stimulated electrically. Release of FFA into the medium by electrical stimulation was markedly lower (~50%) in epididymal fat of irradiated rats, as was spontaneous liberation of FFA. Only very small amounts of FFA were released, with or without stimulation, in reserpine-treated and/or adrenal medullectomized rat tissue. Plasma levels of glucose were higher and plasma FFA levels lower in all irradiation groups, compared with unirradiated controls. Adrenal medullectomy did not appreciably modify the hyperglycemia or reduced FFA mobilization in irradiated animals. It was suggested that the decreased mobilization of FFA after irradiation was due to increased triglyceride synthesis. (BBB)

12790 EFFECTS OF TOTAL BODY SURFACE IRRADIATION WITH ^{90}Sr, ESPECIALLY ON THE HEMATOPOIETIC FUNCTION. Katsube, Yoshio (Tottori Univ., Yonago, Japan). Yonago Igaku Zasshi, 16: 541-58(Dec. 1965). (In Japanese).

Using a hexangular prism irradiation apparatus made of ^{90}Sr-plate, the whole body ^{90}Sr-irradiation of mice was performed. The dose distribution and the effect of irradiation on the hematopoietic function were studied. The results obtained are as follows: For the internal dose measurement, Li-glass rods were placed in the internal organs of mice fixed by formalin. The skin surface doses were about 4000 rad/hour whereas in the central part (duodenum) they were 10 rad/hour, showing that the energy of radiation was rapidly absorbed in the tissues of body surface. The LD_{10} (30 days) of mice was presumed to be about 4000 rad in the skin surface dose, and at this dose various skin reactions from depilation to ulcer were observed. In the irradiation doses below LD_{10}, the peripheral hematocyte count was restored somewhat rapidly, which was then followed by leucocytosis. The larger the dosage the more the hematocyte count was reduced, and the longer became the time required for its restoration. A damaged pattern of the bone marrow was observed in the initial stage; but in the doses below LD_{10} it was restored rather rapidly, thereafter showing a slight hyperplastic pattern. Even in doses as high as 20,000 rad in the skin surface, the state of myelophthisis was not observed. In the spleen, atrophy of lymphatic follicle and proliferation of fibrocyte in red pulp were observed, these increasing with the dosage. In the doses below LD_{50}, they were restored in 7 to 10 days, then a hyperplastic pattern of extramedullary hematopoietic tissue was observed. (NSA of Japan)

12791 MEASURING THE COAGULABILITY OF FIBRINOGEN IN PLASMA BY ISOTOPIC MEANS: METHOD AND PRINCIPLES OF ITS USE FOR IN VIVO STUDIES. Regoeczi, E. (National Inst. for Medical Research, London). Thromb. Diath. Haemorrh., 18: 276-85(1967).

A new radioisotope method was developed as a simple and reproducible technique for measuring the coagulability of plasma fibrinogen that has a coefficient of variance of less than 1%. Oxalated plasma containing trace amounts of radioiodinated fibrinogen was coagulated in a counting tube and its radioactivity measured before and after removing the clot and also after deproteinizing with trichloroacetic acid. To assess the accuracy of the method, batches of radioiodinated fibrinogens from various species were tested in autologous plasma. Samples of radioiodine-labeled serum proteins in clots were examined in human plasmas containing ^{125}I-albumin of ^{131}I-γ-globulin. Aliquots of a fibrinogen preparation radioiodinated at the same mean substitution level yielded practically identical coagulabilities. Aliquots of one ^{131}I-labeled preparation when injected into several healthy animals or mixed with their plasmas gave equal values for coagulability. In normal animals, the coagulable proportion of the circulating protein-bound radioactivity was at any time a function of the extra/intravascular distribution and of the catabolic rate of fibrinogen relative to the corresponding values of the contaminating radioiodine-labeled protein. Significance of the behavior of the noncoagulable protein-bound radioactivities during fibrinogen turnover experiments for the catabolic mechanism was discussed. It is suggested that fibrinogen catabolism is probably an intracellular process. (BBB)

12792 PREPARATION OF RADIOACTIVE GIBBERELLIN A_1 AND ITS METABOLISM IN DWARF PEAS. Kende, H. (Michigan State Univ., East Lansing). Plant Physiol., 42: 1612-18(Nov. 1967).

Tritium-labeled gibberellin A_1 was prepared by selective catalytic reduction of gibberellic acid with a mixture of tritium and hydrogen. It was then applied at physiological concentrations to dwarf peas and the metabolism of the hormone was investigated. The tritium-labeled giberellin A_1 was converted to an acidic, biologically active compound. Radioactive but biologically inactive compounds were also found in the neutral fraction and could not be converted to acidic gibberellins by hydrolysis. No attachment of gibberellin to any macromolecular fraction was evident. (auth)

12793 ELECTRON MICROSCOPY: ENHANCEMENT OF SPECIMEN CONTRAST BY INJECTION OF ATOMS. Manley, J. H. (Los Alamos Scientific Lab., N. Mex.). Science, 158: 1585-7(Dec. 22, 1967).

Injections of biological specimens and substrates with cesium were made with a small accelerator in the energy range of 20 to 1000 electron volts. Subsequent electron microscopic examination

demonstrated that the contrast and appearance of the specimen depend on its structure and on the energy of injection. Substrate noise is decreased over conventional contrasting techniques. The same accelerator provides controlled etching of the specimen. (auth)

12794 FATE OF MACROAGGREGATES OF RADIOALBUMIN IN LUNG. Murphy S., Eduardo; Cervantes R., Celia; Maass E., Roberto (National Commission of Nuclear Energy, Mexico City). Amer. J. Clin. Pathol., 48: 18-22(1967).

Safety in the use of macroaggregated ^{131}I-albumin (used in clinical doses of 250 μCi) was tested in rats and rabbits at the same doses used in humans. On a weight basis this dose in the rat would be about 250 times the indicated amount. The animals were sacrificed at 10, 20, and 120 min after macroaggregate injection, and the lungs and heart examined. The macroaggregate emboli measured from 25 to 50 μ in dia, and were found to obstruct pulmonary capillaries in a semi-homogeneous distribution in all segments of both lungs, with ~1 septal capillary in 200 being occluded. Rupture of the affected vessels, edema, distention of the alveoli, hemorrhagic infarcts, or inflammatory phenomena were not found. At 10 min the macroaggregate emboli were found intact in the capillaries in the distribution described above. At 20 min they were beginning to break down, and at 2 hr only traces of radioactivity could be identified in capillaries, alveolar walls, and spaces. One animal administered 1 mCi in a 2 ml volume died in less than 1 min. The favorable results are probably the result of the rich pulmonary vascular bed and, more significantly, the rapid degradation of the macroaggregates. The lung is an effective filter that prevents macroaggregates from reaching the left chambers of the heart and the coronary circulation. (BBB)

12795 EFFECT OF IONIZING RADIATION ON HISTAMINE. Sturde, H. C.; Heitmann, H. J. (Staedtische Krankenanstalten, Essen). Arch. Klin. Exp. Dermatol., 228: 337-45(1967). (In German).

In contrast to the increases in histamine concentrations that were widely observed in many x-irradiated living organs, the authors report that in aqueous solutions histamine concentrations decreased following x irradiation with 50, 100, 500, 1000, 4000, or 8000 R. The pharmacodynamic action of the solutions, as evaluated by contractile responses of surviving isolated guinea pig intestine, amounted to 80, 70, 50, 40, 10, and 0%, respectively, of the response obtained in comparison to unirradiated histamine solutions. There was no loss of pharmacodynamic effect observed with frozen aqueous histamine solutions or with crystalline histamine, even when they were irradiated with 8000 R. A similar lack of radiation effect was observed when the histamine was irradiated in Tyrode's solution. The results suggested that the radiation affected the histamine indirectly through formation of free, highly reactive radicals in the H_2O. (BBB)

12796 CHANGES OF GOT AND GPT SERUM TRANSAMINASES OF RATS KEPT ON DIFFERENT DIETS AFTER X IRRADIATION. Nemec, R. (Vyskumny Ustav Vyzivy ludu, Bratislava). Cas. Lek. Cesk., 106: 420-4(1967). (In Czech).

The effect on tissue injury, of various saturated and unsaturated fats added to the diet of x-irradiated rats as reflected by release of glutamic-oxaloacetic transaminase (GOT) and glutamic-pyruvic transaminase (GPT) into the circulation was investigated. The Wistar rats received a total dose of 600 R, either in a single dose or six times at 100 R every fifth day. During the first hour after a single dose or after chronic irradiation a significant rise of serum GOT activity occurred. The GPT activity dropped significantly during the first hour after a single dose, yet it did not change substantially after chronic irradiation. A significantly greater increase of GOT and GPT was found on a natural diet in which fats were supplied in the form of margarine and on a synthetic diet that contained sunflower oil at almost all intervals after irradiation. The serum GOT and GPT activities did not change substantially with the synthetic diets that contained olive oil or lard. It was concluded that diets with a higher saturated fatty acid content were more protective from a prophylactic aspect against radiation effects than diets with a high unsaturated fatty acid content. (BBB)

12797 EFFECT OF ^{32}P INTERNAL IRRADIATION ON SERUM GLUCOPROTEINS AND LIPOPROTEINS. Krepsz, I.; Szabo, St.; Kapusi, A.; Mody, E.; Reighel, C.; Csogor, St. Fiziol. Norm. Patol. (Bucharest), 13: 161-4(1967). (In Rumanian).

An approach to the problems of radioprotection in the case of internal irradiation was made by investigating the chemical protective action of serotonin in rabbits, to which ^{32}P was administered. The indexes used were proteinograms, glucido- and lipidograms. In the irradiation disease, the proteinogram underwent significant changes. The behavior of gluco- and lipoproteins was followed, and it is for the first time that their modifications are being studied. It is shown that irradiation with ^{32}P induces disproteinemia with marked blood gluco- and lipoprotein deviations. Serotonin doses can not stop the occurrence of these changes, but attenuate them significantly. (Roumanian Sci. Abstr.)

12798 ROLE OF MICROORGANISMS IN THE MIGRATION OF NATURALLY RADIOACTIVE ELEMENTS IN ROCKS AND SOILS. Krasil'nikov, N. A. (Moscow Univ.). Izv. Akad. Nauk SSSR, Ser. Biol., No. 5, 714-29(Sept.-Oct. 1967). (In Russian).

Microorganisms destroy rocks causing chemical elements, including radioactive ones to weather. Natural radioactive substances are absorbed by microbial cells to be accumulated there in the amount depending on the species and environment. The accumulation coefficient of radioactive substances ranges from 2 to 3 to 10 to 60. Fungi and yeast show the highest absorption of natural radioactive substances, lichens occupying the second place, and actinomycetes and bacteria exhibiting the least absorption. The absorption proceeds actively not only on artificial nutrient media but on the media obtained directly from rocks and soils. Having absorbed natural radioactive substances, microorganisms emit them immediately in the form of separate particles. As a rule, they emit β-particles in a greater amount than α-particles. The β/α ratio may vary within a significant range from 2 to 3 to 10 to 20. Microorganisms can accumulate natural radioactive substances, when occurring in plant tissues. The amount of substances accumulated in nodules is far more than that in roots or stems and leaves. Their concentration is also high in plant tissues infected with phytopathogens or symbionts. The movement of microbial cells containing radioactive elements in rocks and soils determine the migration of these substances. Radioactive substances react with organic compounds, including microbial metabolites, to form complex and chelate compounds. They also can react with amino acids formed by microorganisms. (auth)

12799 THE STIMULATION OF AMINO ACID INCORPORATION INTO THE PROTEIN OF UNFERTILIZED SEA URCHIN EGGS BY γ-IRRADIATION. Rustad, Ronald C. (Western Reserve Univ., Cleveland. (Marine Biological Lab., Woods Hole, Mass.). J. Cell. Physiol., 70: 75-8(Aug. 1967). (COO-78-151).

Control and γ irradiated sea urchin (Arbacia punctulata) eggs were incubated with ^{3}H-leucine. No incorporation of the amino acid into the proteins of most unirradiated eggs were detectable by autoradiography. All irradiated eggs incorporated the amino acid and the amount of autoradiographic labelling varied greatly from cell to cell. (auth)

12800 A DOUBLE-ANTIBODY RADIOIMMUNOASSAY PROCEDURE FOR OVINE PITUITARY PROLACTIN. Aral, Y.; Lee, T. H. (Univ. of Colorado, Denver). Endocrinology, 81: 1041-6(Nov. 1967).

A radioimmunoassay for measuring ovine pituitary prolactin using the double antibody system is reported. Sensitivity range of the method is from 0 to 64 mμg/ml. The ovine prolactin antiserum used in this study showed cross-reaction with bovine prolactin but not against human preparation. Preliminary measurement of serum prolactin levels in nonpregnant, pregnant and post-pregnant sheep is also reported, indicating a gradual decline in prolactin level during pregnancy and a sharp rise post partum and during lactation. (auth)

12801 EXAMINATION OF THE EFFECT OF γ RAYS ON DEOXYRIBONUCLEIC ACIDS. Ciment, D. M.; Overend, W. G. (London Univ.). Arch. Biochem. Biophys., 122: 563-8(Dec. 1967).

Samples of DNA isolated from calf thymus gland and from Bordetella pertussis, representatives respectively of nucleic acids of the adenine-thymine (A-T) and guanine-cytosine (G-C) types were irradiated with γ rays in doses up to those required to give almost complete denaturation. Comparison of the extents of denaturation induced by various doses of γ rays, as determined by loss of irreversibility of the electrometric titration curves, leads to the conclusion that the DNA of the G-C type is more resistant than that of the A-T class. Similar but smaller differences between the nucleic acids were noted when the extent of denaturation was calculated from the increase in intensity of the ultraviolet absorption of the irradiated nucleic acids. (auth)

12802 DEUTERIUM ISOTOPE EFFECTS ON HISTONE SYNTHESIS IN AVIAN ERYTHROBLASTS. Henderson, Thomas R.; Dacus, David M.; Henderson, Rogene F. (Univ. of Arkansas, Little Rock). Arch. Biochem. Biophys., 122: 599-604(Dec. 1967).

The effects of deuterium oxide on lysine-^{14}C incorporation by chicken erythroblasts was investigated. The sensitivity to D_2O of amino acid incorporation into various histone fractions was: $F_{2a} > F_3 > F_1 > F_{2b}$. In addition to the inhibition of histone synthesis, there appears to be a moderate stimulation of orotate-^{14}C uptake into RNA. It is suggested that isotope effects on the control of

histone and RNA synthesis may be related to the inhibitory effects of D_2O on development. (auth)

12803 ELECTRON SPIN RESONANCE STUDY OF IRRADIATED BONE AND ITS CONSTITUENTS. Termine, J. D.; Pullman, I.; Posner, A. S. (Cornell Univ., New York). Arch. Biochem. Biophys., 122: 318-30(Nov. 1967).

Rat femora, fetal calf cancellous and compact bone, demineralized bovine cortical bone, human enamel, and various synthetic calcium phosphates were x-irradiated at 105°K and examined by electron spin resonance spectroscopy at various temperatures. All mineral-containing specimens exhibited a complex main signal and two satellite resonance lines attributed to trapped hydrogen atoms. Satellite signals from mineral samples with large crystal sizes showed a fine detail probably due to proton interaction, possibly from hydroxide ions. Noncrystalline calcium phosphate yielded spectra different from those of crystalline apatite, and percentage crystallinity measurements based on these differences indicated that bone tissue contains both of these phases. Low-temperature spectra of demineralized bone protein and young rat femora exhibited poor resolution attributed to interference by collagen degradation products in the former and noncollagenous proteins in the latter case. Resonance signals from mechanical mixtures of organic bone matrix and synthetic calcium phosphates differed qualitatively and quantitatively from those of bone tissue itself. These data indicate that a transfer of free radical electron spin energy may take place between bone mineral and bone protein. Thus it is suggested that there is an intimate interaction, perhaps through chemical bonding, between the organic and mineral phases of skeletal tissue. (auth)

12804 AUTORADIOGRAPHIC LOCALIZATION OF THE ACTIVE CONCENTRATION MECHANISM OF RADIOIODIDE IN THE TRACHEA OF GUINEA PIGS WITH OBSERVATIONS ON ^{35}SCN, ^{36}Cl, AND ^{58}Co. Kleine, Tilmann O. (Univ., Heidelberg). Arch. Pharmakol. Exp. Pathol., 257: 172-92(1967). (In German).

In vivo and in vitro experiments were conducted on ^{125}I, ^{131}I, ^{36}Cl, ^{58}Co, and ^{35}S-thiocyanate uptake in guinea pig tracheal cells. It was found that the active concentration of radioiodide takes place in both directions, probably in special cells in layers of the tracheal epithelium which are nearest to the lumen, both in vitro and in vivo. Which of the three epithelial cell types (cilia, brush, or goblet cell) participates in this active process is discussed. In vitro the active concentration mechanism of the cells is disturbed by atropine sulfate, KCN, NaF, 2,4-dinitrophenol, and monoiodoacetate, as well as by long incubation in a Ringer phosphate-glucose medium. Under these conditions a diffusion of radioiodide through the trachea, probably due to the changes in the metabolism of the cells, could be seen. Radioiodide and ^{35}S-labeled thiocyanate was autoradiographically localized in the cytoplasm and intercellular zone in the tracheal epithelium of guinea pigs. In vitro, $^{35}SCN^-$ and $^{36}Cl^-$ were localized similarly in the cytoplasm of epithelial cells of the guinea pig trachea. In vivo the perichondrium of tracheal cartilage accumulated $^{35}SCN^-$; in vitro it did not. In the tracheal glands radioiodide, $^{35}SCN^-$, and $^{36}Cl^-$ were localized in the cytoplasm of secreting cells as well as in the lumen, whereas ^{58}Co was only adsorbed on the surface of epithelial cells. (BBB)

12805 NATURE OF THE SECONDARY RESPONSE. Coons, A. H. (Harvard Medical School, Boston). pp 559-66 of Molecular and Cellular Basis of Antibody Formation. Proceedings of a Symposium, Prague, June 1 to 5, 1964. New York, Academic Press, 1965.

The effect of ionizing radiation and other factors on the secondary immunologic response is reviewed. The nature of the antibody-producing cell has been studied in radiobiologic experiments. The cell which initiates the response was studied by infusing labeled mature lymphocytes derived from thoracic duct lymph into x irradiated rats of a different strain; 24 hours later in the spleen of the recipients there were large labeled cells like primitive plasma cells. This result was interpreted as indicating that small lymphocytes could differentiate into precursors of the plasmocyte line. When pulses of tritiated thymidine were given to animals 2 hr before a secondary antigenic stimulus, large, blast-like cells labeled in radioautographs were found immediately after antigen injection and subsequently the developing plasma cells resulting from the stimulus were all labeled. Evidently the plasma cell line arose from primitive cells which were continuously dividing and able to make a specific response on recall stimulation. Study of effect of the interval between antigen injections on subsequent secondary responses in mice showed that the secondary response increased as the interval was lengthened from 10 to 20 days, and then tended to level off so that when the interval was 40 days or longer, up to half a year, the maximum secondary response stayed relatively constant. This indicated that there is no slow steady multiplication of a line of cells which has become sensitized or primed to antigen. Rather, priming appears to be a deliberate process, requiring some 3 to 4 weeks. The same steady number of primed cells was found in cell transfer experiments from primed donors to x irradiated isogenic recipients, regardless of the duration of residence in the recipient before the transferred cells encountered a recall dose of antigen. Distinction between the priming and induction phases of antibody formation is delineated. (BBB)

12806 IN VIVO CLEAVAGE OF A CIRCULAR, SINGLE-STRANDED DNA OF BACTERIOPHAGE ϕR IRRADIATED WITH ULTRAVIOLET LIGHT. Ono, Joji; Shimazu, Yoshie (National Inst. of Radiological Sciences, Chiba, Japan). J. Mol. Biol., 24: 491-5(1967).

Some strains of Escherichia coli (such as B/r) excise thymine dimers produced in DNA molecules by irradiation with uv light, whereas others (such as Bs-1, a uv-sensitive derivative of B/r) fail to excise this photoproduct. The repair process of uv-damaged DNA has been suggested, therefore, to involve the incision of thymine dimers. Direct evidence for excised molecules can be obtained from the analysis of single-stranded DNA, since the integrity of the DNA should be abolished immediately after excision of the lesion. An attempt was made to determine whether one biochemical aspect of the repair of uv lesions produced in DNA is the excision of lesions leading to scission of the DNA strand. Thus, the fate of single-stranded DNA of uv-irradiated bacteriophage ϕR was followed after infection of host bacteria, E. coli C, that carries out host reactivation for phage λ, and E. coli Csyn$^-$ that is a uv-sensitive derivative that cannot carry out host reactivation for phage λ. Tritium labeled ϕR was purified from the lysate of ϕR-infected E. coli 15T$^-$ grown in the presence of ^3H-thymidine. The fate of the single-stranded DNA after uv irradiation was examined after extraction from complexes infected in the presence of KCN. Since the inferred conversion of single-stranded, circular uv-irradiated DNA into an opened linear structure was observed only when infection was carried out in E. coli C but not in E. coli Csyn$^-$, a scission enzyme that attacks uv lesions on a DNA strand must be present in E. coli C but not in E. coli Csyn$^-$. The absence of host-reactivation of uv-irradiated phage containing a single-stranded DNA must be the result of the destruction of the integrity of the phage DNA by enzymic scission at the site of uv lesions, which is characteristic of the repair process of damaged DNA, and should not be attributed to the failure to eliminate the lesion. (BBB)

12807 DISTRIBUTION OF ^{35}S IN PROTEIN OF STRUCTURAL ELEMENTS IN LIVER CELLS OF RATS EXPOSED TO CHRONIC TREATMENT WITH RADIOACTIVE SULFATE. Arutyunyan, T. L.; Orlyanskaya, R. L. Zh. Eksp. Klin. Med., 7: No. 3, 13-18(1967). (In Russian).

Under conditions of protracted treatment of radioactive sulfate at a dose of 1 μg/g of weight, the distribution of the activity of ^{35}S takes place according to the quantity of the total protein. The highest activities are on fractions of nuclei, then supernatant and mitochondria. During protracted treatment with $Na_2{}^{35}SO_4$, a decrease of the total quantity of protein was observed in fractions of supernatant of liver from the fourth to the sixth month of treatment and in comparison with the corresponding controls. The incorporation of ^{32}P in supernatant fractions after six months of treatment is reduced and amounts to 34.1% of the activity of the investigated fraction of the control group. (tr-auth)

12808 CHANGES IN THE SH-GROUP CONTENT IN HEART MUSCLES OF RATS SUFFERING FROM ACUTE RADIATION SICKNESS. Movsesyan, M. A. Zh. Eksp. Klin. Med., 7: No. 3, 3-5(1967). (In Russian).

Data on the content of SH-groups in heart muscles of rats suffering from acute radiation sickness were reported. Rats were exposed to x-ray doses of 800 R. Within five min, 24 hrs, and 5, 10, 15, and 20 days, the SH content of the heart muscles was determined by amperometric titration. The results are tabulated. (tr-auth)

12809 EXPERIMENTAL IMMUNIZATION IN WHITE MICE AND RHESUS MONKEYS WITH S. JAPONICUM IRRADIATED CERCARIAE. de la Cruz, B.; Pesigan, T.; Banzon, T.; Bautista, S. Philippines Nucl. J., 1: 59-62(Jan. 1967).

White mice and rhesus monkeys which were immunized with cercariae exposed to 1,500 up to 2,500 R of x rays developed resistance against Schistosoma japonicum infection. The protection afforded by immunization of these animals with irradiated cercariae was seen more in the monkeys. (auth)

12810 TUMOR-SPECIFIC ANTIGEN(S) IN A SPONTANEOUS MAMMARY CARCINOMA OF C3H MICE. II. ACTIVE IMMUNIZATION OF MAMMARY-TUMOR-AGENT-FREE MICE. Suit, H. D.; Silobrcic, V. (Univ. of Texas, Houston). J. Nat. Cancer Inst., 39: 1121-8(Dec. 1967).

Mice, which do not carry a mammary tumor agent (MTA) that induces development of breast carcinoma, were actively immunized by: three injections of radiation-killed tumor cells at weekly intervals, Freund's adjuvant being included in the first injection, or a tumor transplant allowed to grow to ≈250 mm^3 and then exposed to a tumor lethal dose of x radiation. In both instances, this immunity was adoptively transferred. Normal spleen and lymph node cells were not effective in immunizing against the tumor. The results contrasted with those from studies based on C3H/He and (C3H/He × C57BL)F_1 mice that do carry the MTA. In these animals immunization against subsequent challenge to the mammary carcinoma was not achieved. Tests for presence of enhancing or cytotoxic antibodies in sera of (C57BL × C3H/He)F_1 mice bearing a transplanted mammary carcinoma were negative. (auth)

12811 EFFECT OF X IRRADIATION AND THYMECTOMY ON THE DEVELOPMENT OF MYCOBACTERIUM LEPRAE INFECTION IN MICE. Gaugas, J. M. (Guy's Hospital, London). Brit. J. Exp. Pathol., 48: 417-22(Aug. 1967).

Several treatments were used to reduce the immunological response in mice to Mycobacterium leprae. Whole-body x irradiation at a dose rate of 42 R/min was administered on the day of challenge with the micro-organisms. Mice that received a potentially lethal dose of x rays, 900 R, in a single session were protected from death by subsequent injection of homologous bone marrow cells that are immunologically incompetent. In addition, animals receiving sublethal doses, 420 R, were irradiated after two months and then monthly, until a total of about 10^6 microorganisms were extracted from an untreated control, i.e., a total of 2520 to 2940 R was given. Using the mouse-hind-foot-pad technique, inoculation of ~5.0×10^3 M. leprae resulted in only a limited type of multiplication. General immunosuppressive treatment by thymectomy, potentially lethal irradiation, (900 R in mice protected by marrow transplantation) or repeated sublethal doses of x rays (420 R) produced only a slight increase in susceptibility to infection. However, thymectomy combined with exposure to 900 R of x radiation resulted in much higher multiplication of the bacteria. This combination led to a maximum (16,800-fold) increase of the total initial inoculum number of bacteria from its inception; a 560-fold increase occurred in untreated controls. The nature of the host's defensive mechanism that halts bacterial multiplication is discussed. Macroscopic lesions were not found and there was no spread of infection from the site of inoculation. (BBB)

12812 TUMOR-SPECIFIC ANTIGEN(S) IN A SPONTANEOUS MAMMARY CARCINOMA OF C3H MICE. I. QUANTITATIVE CELL TRANSPLANTS INTO MAMMARY-TUMOR-AGENT-POSITIVE AND -FREE MICE. Silobrcic, V.; Suit, H. D. (Univ. of Texas, Houston). J. Nat. Cancer Inst., 39: 1113-19(Dec. 1967).

Results of a series of quantitative assays of transplantability of a C3H/He mouse mammary carcinoma are described. Recipient mice were either isologous or F_1 hybrids, and either mammary-tumor-agent (MTA)-positive or -free. All transplants were performed with tumor cells of second-generation isotransplants derived from a single tumor. Transplantability of this tumor was not affected by the MTA status or sex of the recipient, nor were the tumor-take rates in MTA-positive and MTA-free hosts influenced by 400 rads of whole-body irradiation. These results are discussed in relation to those obtained by other investigators under different experimental conditions. (auth)

12813 ULTRASTRUCTURAL CHANGES OF THYROID INTRAOCULAR GRAFTS X-IRRADIATED IN VITRO BEFORE TRANSPLANTATION. Pantic, V.; Pavlovic-Hournac, Miroslava R.; Radivojevic, Dusanka V. (Inst. for the Application of Nuclear Energy in Agriculture, Veterinary Medicine and Forestry, Belgrade. Boris Kidric Inst. of Nuclear Sciences, Belgrade). Int. J. Radiat. Biol., 12: 305-16(1967).

The ultrastructure of four-month-old thyroid grafts x irradiated with 600 R and 1800 R in vitro before transplantation was investigated. Radiation effects that were dose-dependent induced very pronounced changes in all cellular organelles. The decreased number of mitosis and follicular formation was due to irregularities in condensation and lower quantity of stained chromatin. The lipoprotein membranes of all cell organelles were disorganized and discontinued, having more osmiophilic character. They often lost the usual appearance of a layered structure, especially in microvilli and mitochondria. The endoplasmic reticulum was reduced, forming dilated canalicules and cisternae. The ribosomes were unequally attached to the surface of the endoplasmic reticulum and free polysomes were in groups showing signs of agglomerations. Golgi zones composed of large osmiophilic vesicles increased in number and were often located close to the basal part of plasma membrane together with small vesicles of varying density. The increased number of dense bodies was found in the cells with decreased resorptive capability and sensitivity to stimulation with TSH. The parafollicular cells of grafts irradiated with 1800 R had characteristic vesicles and short granular cytomembranes. (auth)

12814 LOCAL AND GENERALIZED EFFECTS OF LOCAL RADIATION. I. EFFECTS OF LOCAL RADIATION TO THE LIVER AND UPPER INTESTINES IN PARTIALLY HEPATECTOMIZED, SHAM-OPERATED, AND NORMAL RATS. Looney, W. B.; Chang, L. O. (Univ. of Virginia, Charlottesville). Radiology, 89: 906-18(Nov. 1967).

Local x radiation to the liver and underlying intestines of rats resulted in the immediate depression of DNA synthesis. The depressing effect continued over the two-day period of the study. Maximum depression appeared to occur at eight hours, with recovery in individual cells at twenty-four hours after doses ranging from 94 to 1,500 R. Depression of DNA synthesis at times later than eight hours appeared to be from the inhibition of cells initiating DNA synthesis. Depression of DNA synthesis was also found in the shielded thymus and lower intestines in the same animals, and the same general pattern was found in the shielded organs at comparable times after irradiation. These results and the results of similar investigations suggest that one component of the biphasic DNA synthetic dose response curve may be related to the immediate and direct effects of irradiation, while the second component may be related to the delayed and generalized effects of irradiation. This generalized effect of local irradiation raises the possibility of one systemic factor affecting DNA synthesis, and another affecting mitotic activity. (C.H.)

12815 DEMONSTRATION OF AN EARLY HOST-GRAFT INCOMPATIBILITY REACTION IN RADIATION CHIMERAS WITH THE JERNE PLAQUE TECHNIQUE. Gengozian, N.; Gottlieb, C. F.; Allen, E. M. (Oak Ridge Inst. of Nuclear Studies, Tenn.). Proc. Soc. Exp. Biol. Med., 126: 135-40(Oct. 1967).

The Jerne plaque technique was used to demonstrate the presence of an early immunologic reaction between host and donor tissues in lethally irradiated mice treated with rat or hamster bone marrow. Evidence for both host and graft activity was obtained from spleen cells of mice that were treated with hamster bone marrow. The responses obtained were of low magnitude and variable, and were evident primarily through the first 6 days posttreatment. A cause and effect relation of this early immune reaction to the etiology of secondary disease in foreign marrow radiation chimeras is suggested. (auth)

12816 TETRACYCLINE FLUORESCENCE AND ENZYME HISTOCHEMISTRY ON EARLY RADIATION DAMAGE IN MOUSE KIDNEY. Raekallio, J.; Lindgren, I. (Univ. of Turku, Finland). Acta Radiol., Ther., Phys., Biol., 6: 202-8(June 1967).

Irradiated mouse kidneys were studied by tetracycline fluorescence and enzyme histochemistry to investigate early radiation damage. There was an increase in the tetracycline fluorescence of tubule cells as early as 2–4 hrs after irradiation. Aminopeptidase and cytochrome oxidase activity decreased at 4 hrs, and acid phosphatase at 8 hrs. At 24 hrs, there were large cortical areas, showing little or no enzyme activity. The changes in enzyme activity and in tetracycline fluorescence revealed early signs of imminent necrosis, long before there was histological evidence of cell damage. (auth) (Sweden)

12817 THERMAL SPIKE EFFECTS IN HEAVY-ION TRACKS. Norman, Amos (Univ. of California, Los Angeles). Radiat. Res., Suppl. 7, 33-7(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

The material within heavy-ion tracks is raised to a high temperature with the following consequences: the rates of various physical and chemical processes are greatly increased, and the heated material expands explosively. This model can account for some observed LET and temperature effects in radiation biology and radiation chemistry, and it accounts very well for radiation nucleation in liquids. (auth)

12818 INACTIVATION OF RIBONUCLEASE BY ELASTIC NUCLEAR COLLISIONS. Jung, Horst (Kernforschungszentrum, Karlsruhe, Ger.). Radiat. Res., Suppl. 7, 64-73(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

The inactivation cross section of thin layers of RNAase irradiated with slow protons was determined in the 0.8 to 60 keV range. The inactivation cross section was not strongly dependent on energy at high energies, but it decreased as the proton energy was decreased, reaching a minimum at 1.2 keV; it increased at lower energies. When the experimentally determined inactivation cross sections were compared to the cross sections for elastic nuclear collision energy losses and for ionizations, it was demonstrated that elastic collisions destroyed the enzymatic activity of RNAse.

Only one fourth of the energy required for inactivation by ionization was required for inactivation by nuclear collisions. (M.M.B.)

12819 INACTIVATION AT VARIOUS TEMPERATURES OF THE ESTERASE ACTIVITY OF DRIED TRYPSIN BY RADIATIONS OF DIFFERENT LET. Brustad, Tor (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Radiat. Res., Suppl. 7, 74-86(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Inactivation by heavy ions of the esterase activity of dried trypsin was studied as a function of the temperature of the samples during irradiation (10°K to 430°K). The LET range from 45 MeV-cm^2/g to about 13,000 MeV-cm^2/g was investigated by using stripped nuclei of argon, neon, carbon, boron, helium, and deuterium. For all radiations used, the radiosensitivity was found to be essentially constant when the exposure was carried out at temperatures below about 100°K. When irradiation was performed at higher temperatures the radiosensitivity increased with increasing temperature, but this increase was less pronounced when radiation of high LET was used. These effects were observed only if the samples were subjected to heat and radiation simultaneously. (auth)

12820 ELECTRON SPIN RESONANCE STUDIES ON PROTON-IRRADIATED RIBONUCLEASE AND LYSOZYME. Stratton, K. (Massachusetts General Hospital, Boston). Radiat. Res., Suppl. 7, 102-15(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

The long-lived radicals produced in crystalline ribonuclease and lysozyme by 120-MeV proton, Bragg peak proton, and ^{60}Co gamma irradiation were studied by electron spin resonance (ESR) spectroscopy. The proton irradiations did not produce any resonance spectra markedly different from those obtained after ^{60}Co irradiation at the same temperature. However, higher LET radiation ($\bar{E}$ ~ 300-keV neutrons) at 77°K did give rise to a different spectrum. The efficiency of production of long-lived radicals in these enzymes by Bragg peak protons relative to ^{60}Co gammas was 0.85 ± 0.02, but there was some dose-rate dependence, especially for lysozyme. Raising the temperature from 77°K to 298°K caused about 20% reduction in the total number of radicals remaining, but irradiation at 298°K gave similar or greater radical yields than at 77°K. Saturation of the radical concentration occurred for high doses, both at 77°K and at room temperature, in vacuo and in air. The radical saturation levels in air were lower by a factor of about 3 than in vacuum. The secondary processes giving rise to sulfur-type radicals were observed in annealing studies. Change due to the presence of oxygen during or after irradiation was found to be greater for ribonuclease than for lysozyme. No sulfur radicals were detected in ribonuclease after irradiation in air, but sulfur radicals already present after irradiation in vacuo were relatively stable to later admission of oxygen. (auth)

12821 INACTIVATION AND TRAPPED RADICALS IN DRY TRYPSIN EXPOSED TO ULTRAVIOLET LIGHT. Steen, H. B.; Brustad, T. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Radiat. Res., Suppl. 7, 116-27(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

The causal relation between the trapped radicals and the inactivation of solid trypsin exposed to uv light was investigated by measuring the concentration of radicals and the degree of inactivation as functions of exposure time and wavelength. The various wavelengths were obtained by irradiation with a polychromatic light source through optical filters that were opaque below different wavelengths. The number of trapped radicals per inactivated molecule varied from approximately 0.2 for wavelengths below 3000 Å, to 0.004 at 3340 Å. Between 3130 and 3340 Å the ESR spectrum changed significantly. There was good agreement between the photon energy corresponding to this range of wavelength, and the dissociation energies of N–H and C–H bonds. The results made it unlikely that the inactivation was due entirely to the trapped free radicals. For uv light of wavelength below 3000 Å, however, a significant contribution to the inactivation due to the trapped radicals seems possible. For uv light of wavelength above 3000 Å, such a contribution must be very small. (auth)

12822 EXCITATION, DISSIPATIVE, AND EMISSIVE MECHANISMS IN BIOCHEMICALS. Augenstein, Leroy (Michigan State Univ., East Lansing); Yeargers, Edward; Carter, James; Nelson, DeVaughn. Radiat. Res., Suppl. 7, 128-38(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Fluorescence and phosphorescence from tryptophan powder at low temperatures was stimulated with uv, vacuum uv, fast electrons, and x rays. Radiationless conversions between higher-excited singlet and triplet states and the ground state were efficient but temperature-insensitive. The data indicated that both optically forbidden and optically allowed transitions produced by fast and slow electrons were probably important in the light emitted as a result of x irradiation. (auth)

12823 ULTRAVIOLET-INDUCED EXCITED STATES IN DEOXYRIBONUCLEIC ACID. Rahn, Ronald O.; Shulman, R. G.; Longworth, J. W. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Radiat. Res., Suppl. 7, 139-46(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Waals and Groot [Mol. Phys. 3: 190-200(1960)] and Pershan, Shulman, Wyluda, and Eisinger V [Physics 1: 163-182(1964)] have shown that the phosphorescence from native DNA is not the sum of the emission from the individual nucleotides. Evidence from ESR and optical emission studies is presented that shows the triplet state of DNA has properties similar to that of ionized thymidine. Because thymidine phosphoresces only on losing its N_3 proton (pH = 9.8), these results are consistent with an effective transfer of this proton in the hydrogen-bonded polynucleotides from thymine to adenine upon ultraviolet excitation. (auth)

12824 MOLECULAR EVENTS RESULTING IN RADIATION INJURY, REPAIR AND SENSITIZATION OF DNA. Szybalski, Waclaw (Univ. of Wisconsin, Madison). Radiat. Res., Suppl. 7, 147-59(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

A model is proposed to unify the data pertaining to the lethal effects of x rays on DNA, phages, and cellular organisms. The principal target of lethal radiation effects is DNA. Within the DNA molecule two targets can be distinguished: the phosphate ester bonds, and the pyrimidine nucleotides. The three types of damage that occur in molecules suspended in an aqueous environment are as follows: direct damage, probably rare in oxygenated media that results in double- or single-strand breaks; indirect damage mediated by radicals that cause double- or single-strand breaks and that are quenched by radical scavengers, e.g., histidine or SH-containing compounds; and indirect damage mediated by another class of radicals, the formation or action of which depends on the presence of oxygen and leads to chemical damage to the pyrimidine bases. This damage is depressed by the absence of oxygen, or by the addition of SH-containing compounds but not by radical scavengers of the histidine class. (M.M.B.)

12825 HEAVY-ION IRRADIATION OF CULTURED HUMAN CELLS. Todd, Paul (Univ. of California, Berkeley). Radiat. Res., Suppl. 7, 196-207(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Some aspects of the radiosensitivity of single human cells were examined in vitro. So far, all factors that tended to modify sensitivity to x radiation appeared not to modify (or to modify less effectively) the effect on single cells of high-dE/dx radiation. In the case of cultured human cells, the RBE was dependent on the end point because of the differently shaped survival curves. Thus, for example, the RBE of fast carbon ions for 50% survival was about 6, whereas it was only about 2 for 1% survival. The applicability of these findings to the evaluation of the hazards of particulate radiation awaits further understanding of the sequelae of the inhibition of cellular reproduction. (auth)

Ecology

Refer also to abstracts 12896 and 13371.

12826 (IDO–12063) CONTROLLED ENVIRONMENTAL RADIOIODINE TESTS. Progress Report No. 3. Bunch, D. F. (ed.) (Idaho Operations Office (AEC), Idaho Falls. Health and Safety Div.). Jan. 1968. 77p. Dep. CFSTI.

The emergence of nuclear reactors as competitive alternates for the production of electricity gave new impetus to the solution of questions regarding the behavior of radioactive materials in the environment. The Controlled Environmental Radioiodine Tests (CERT) program consists of field releases of various chemical species of radioiodine over different types of vegetation and during various meteorological conditions. Data collected from these releases are being used to derive empirical models that describe the movement of iodine through the air-vegetation-cow-milk-human chain. Information gathered during 1966, as well as a compilation of data relating to and including the deposition of I_2 and CH_3I over a wide range of meteorological conditions, is presented. (auth)

12827 BIOGEOCHEMISTRY OF STRONTIUM: WITH DISCUSSION OF THE ECOLOGICAL INTEGRATION OF ELEMENTS. Odum, Howard Thomas. New Haven, Yale Univ., 1950. 383p. Thesis.

By means of a flame photometric apparatus constructed for the purpose, 1100 determinations were made of Sr in the main phases of nature, and these analyses used to construct a quantitative cycle of the element in its passage from land to rivers, to the sea, to the sediments and back to the land with orogenic uplift. The Sr cycle is shown to contain a self balancing mechanism, and by means of inferences from fossil analyses, a past history of approximate steady state of the Sr/Ca ratio has been demonstrated. The cycle is discussed in terms of cog wheel analogies, criteria of stability, distribution factors, and other concepts which have application to other ecological systems. Patterns and principles controlling the detailed distribution of Sr in rocks, waters, sediments, organisms, and the atmosphere were demonstrated. The concepts of levels of integrations were used to distinguish between the action of Goldschmidt's ionic radius principle in a crystal formation and the cumulative action of this and other principles in the distribution of Sr in nature, the most important factor being the distribution of concentrations as determined by ecological patterns of the whole cycle. Properties of variation are shown also to depend on the whole cycle. Strontium is a conservative element in the ocean. The regional patterns of Sr in igneous rocks are explained by the behavior of Sr in fractional crystallizations and do not require the elaborate theories previously proposed. The biological deposition of $Ca(CO_3)_2$ in laboratory snails and in nature was shown to be a function of the Sr in the medium. The Sr/Ca ratio in skeletal deposition was about three times smaller than in the medium. Snails in culture were raised with shells containing half Sr. An inverse pattern of Sr/Ca and Ca was observed in many phases of nature; a possible general significance of this inverse pattern is discussed. The great complexity of factors determining Sr distribution in organisms is discussed and empirical patterns observed. Phase boundaries are characterized on the average by a distribution factor of about 3 for Sr/Ca ratios. As a byproduct of the construction of the strontium cycle, cycles of many major elements have provided a first approximation to a balanced geochemical system for the world. The balancing method of approach is a source of new information such as the confirmation that was found for the reported discrepancies in Clarke's estimates of Na in sediments. (TSS) (Disser. Abstr.)

Genetics and Cytogenetics

Refer also to abstract 12868.

12828 A STUDY OF THE MUTAGENIC EFFECT OF ULTRAVIOLET LIGHT ON ACTINOMYCETES ANTIBIOTICALLY ACTIVE AGAINST CRYPTOCOCCUS NEOFORMANS. Bezjak, V.; Makis, J.; Beakovic, J.; Ponte, I. Acta Med. Iugoslav., 19: 263-92(1965).

Numerous strains of actinomycetes were exposed to 2800-Å uv radiation at near-lethal doses and the surviving clones were tested for antibiotic activity against Cryptococcus neoformans. It was found that the same dose of uv radiation did not have the same effect on antibiotic activity of different strains of actinomycetes. A single exposure could produce either an increase or a decrease of antibiotic activity, or produce no effect at all. Within the population of original nonirradiated strains which were antibiotically active against C. neoformans, there were some inactive variants, usually between 15 and 60%. Populations of the strains of actinomycetes which were exposed to uv only once consisted of some inactive variants, the incidence of which usually varied between 4 and 35%. The incidence of plus-variants in populations of both nonirradiated and irradiated strains did not exceed 32%. The incidence of minus-variants in original strains of actinomycetes usually was greater than the incidence of plus-variants, but not in the strains exposed to uv only once. Subculture populations of the most active plus-mutants induced by uv showed, as a rule, considerably reduced antibiotic activity. (BBB)

12829 PROBLEMS OF SPACE GENETICS. Dubinin, N. P. (Inst. of General Genetics, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol., No. 5, 669-81(Sept.-Oct. 1967). (In Russian).

Space genetics deals with four major problems; factors causing mutations under space flight conditions and nature of mutations developing in this unusual environment, selection of new forms of organisms for the closed ecological system of the spacecraft, evaluation of the effect of various space flight factors on the heredity of different organisms and development of protective measures to ensure reliable performance of the ecological system components, and study of molecular, cytologic and genetic aspects of heredity of extraterrestrial life forms. Space genetics is a new branch of science and, similarly to other aspects of cosmology, it has unbounded prospects of its further development. The Institute of General Genetics has organized a large laboratory of space genetics which is engaged in studies of the mutagenic effect of space flight factors, protection against their influence and selection of lower and higher plants necessary for the ecological system of the spacecraft. The scope of the biological exploration of outer space is being extended. In the near future long duration space flights through radiation belts will be performed. The Moon will become the place of continuous research work and the launch ground for space vehicles. We hope that the Institute of General Genetics of the USSR Academy of Sciences will contribute to the advancement of the above aspects of space biology and medicine. (auth)

12830 NON-INTERACTION OF RADIATION-INDUCED CHROMOSOME LESIONS IN TRADESCANTIA MICROSPORES. II. AN ATTEMPT TO DETECT INACTIVATION OF CHROMOSOME-EXCHANGE SITES WITH NEUTRON X-RAY FRACTIONATION. Savage, John R. K. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol., 12: 373-81(1967).

An x-ray response curve for chromosome exchanges in Tradescantia microspores was obtained after a priming dose of 0.7 MeV fast neutrons. The observed yield was significantly below that expected if the neutron and x-ray doses acted independently. The deficiency in yield could be quantitatively accounted for if the number of sites in the original population of cells was limited, and some of them were no longer available to the second x-ray fraction because they had been utilized for exchange by the neutron priming dose. Two conclusions could be drawn from the results: Site inactivation did not appear to be an important consequence of irradiation by neutrons and neutrons and x-rays can act on the same exchange sites. (auth)

12831 MUTATION IN DROSOPHILA MELANOGASTER CULTURED ON IRRADIATED WHOLE FOOD OR FOOD COMPONENTS. Rinehart, Robert R.; Ratty, F. J. (San Diego State Coll., Calif.). Int. J. Radiat. Biol., 12: 347-54(1967).

The frequencies of sex-linked recessive lethal mutations were measured in germ cells from Drosophila males cultured on aged or non-aged, irradiated or non-irradiated whole food or food supplements. The results indicated that irradiated whole food, autoclaved sucrose, and heterologous DNA were mutagenic. Non-autoclaved sucrose, whether irradiated or not, did not induce mutations. A large portion of the increased damage could be associated with the induction of gonial mutants. Aging the treated food or food components for three weeks before use did not alter the results. (auth)

12832 CHROMOSOME ABERRATIONS AND THE THEORY OF RBE. III. EVIDENCE FROM EXPERIMENTS WITH SOFT X-RAYS, AND A CONSIDERATION OF THE EFFECTS OF HARD X-RAYS. Neary, G. J.; Preston, R. J.; Savage, J. R. K. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol., 12: 317-45(1967).

Production of chromatid-type aberrations in the generative nucleus of mature pollen of Tradescantia bracteata by monochromatic soft x-rays and hard x- and gamma-rays, and the modifying effect of oxygen were investigated. Even the lowest energy x-rays, formerly thought to be ineffective, produced aberrations. The effectiveness of a short electron track in producing an aberration depended on its track-length as well as its LET, but the modifying effect of oxygen depended only on the LET. The results were consistent with a model of aberration production in which a primary lesion in a chromosome was produced by one energy-loss event (about 60 ev) in a structure of the order of 1 mμ in thickness, and an aberration resulted from the interaction of two damaged structures in a site with a radius of the order of 0.2 μ. On the basis of this model derived from data at well-defined LET values, the effectiveness of hard x- or gamma-rays could be accounted for by reference to their LET distributions. The effective LET for aberration production depended on the characteristic site-radius for the particular type of aberration in the cells considered. (auth)

12833 MODIFICATION OF X-RAY-INDUCED MUTATION FREQUENCY BY POST-TREATMENT WITH PLASMA FACTORS IN MICE. Reddi, O. S.; Naidu, N. V. (Osmania Univ., Hyderabad, India). Int. J. Radiat. Biol., 12: 397-9(1967).

Successful alteration of the frequency of x-ray induced dominant lethal mutations in rats by postirradiation treatment with factors from the plasma of anemic and nonanemic bullocks is reported. Three groups of six male mice of C_3H/He strain were x-irradiated with a 700 R dose; the control group received no treatment. Two experimental groups were administered intraperitoneally 0.5 mg of a dessicated fraction of a 60 to 80% alcoholic precipitate of boiled filtrates of plasma for three consecu-

tive days. The material used in one group was derived from anemic bullocks and in the other group from nonanemic bullocks. The treated and untreated males were given three females each of 101 strain; females were checked daily for vaginal plugs and mated females were replaced. The uteri of females were checked for living and dead or resorbed embryos; ovaries were screened for corpora lutea. The percentage of viable embryos was significantly higher in treated groups; $\chi^2 = 5.35$ and 45.52 for material from nonanemic and anemic bullocks, respectively. The significant decrease in the frequency of dead embryos in the treated group strongly suggested antimutagenic effects of the plasma factor(s) tested. (B.H.S.)

12834 MITOTIC DELAY AND CHROMOSOMAL ABERRATIONS INDUCED BY X RAYS IN SYNCHRONIZED CHINESE HAMSTER CELLS IN VITRO. Yu, C. K.; Sinclair, W. K. (Argonne National Lab., Ill.). J. Nat. Cancer Inst., 39: 619-32(Oct. 1967).

Synchronized Chinese hamster cell populations in vitro were irradiated at different stages of the cell cycle and examined at the next metaphase. Mitotic delay varied according to the stage of the cell cycle at the time of irradiation. It was greatest for cells irradiated in middle to late S, moderate for cells irradiated in G_2, and least for cells irradiated in G_1. It increased approximately linearly with dose (0.7 hr./100 rad for S cells and 0.3 hr./100 rad for G_1 cells). Chromosomal aberration rates also depended on the stage of the cell cycle at which the cells were irradiated. Chromatid aberrations were induced mostly during G_2 and S (more in early S than late S), while chromosome aberrations were induced mainly in G_1. Total breaks after 500 or 750 R showed a minimum frequency in late S and a maximum frequency in G_2. This form of response correlates, but only in a general qualitative way, with the dependence of survival on cell cycle stage previously reported. Mitotic delay has a dependence on cell cycle stage quite different from either chromosomal aberrations or survival. (auth)

12835 MUTATION-INDUCTION AND NUCLEAR INACTIVATION IN NEUROSPORA CRASSA USING RADIATIONS WITH DIFFERENT RATES OF ENERGY LOSS. de Serres, F. J.; Webber, B. B.; Lyman, J. T. (Oak Ridge National Lab., Tenn. Univ. of California, Berkeley). Contract W-7405-eng-26. Radiat. Res., Suppl. 7, 160-71(1967). (ORNL-P-1727).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

A comparison of the effects of 250-kVp x rays, 40-MeV helium ions, and 108-MeV carbon ions on mutation induction and nuclear inactivation was made with a heterokaryon of Neurospora crassa. The RBE's for mutation induction at two separate loci in the ad-3 region were 1.8 for helium ions and 5.0 for carbon ions. The RBE's for inactivation of the heterokaryotic conidia were 1.7 for helium ions and 5.3 for carbon ions. The relative efficiency of carbon ions for mutation induction was higher in Neurospora than in other organisms. This difference was attributed to the recovery of a class of mutations (extragenic alterations) that has not been studied with other test systems. Ad-3A ad-3B double mutants, which increase as the square of the dose with x-rays and helium ions, increased as the 1.45 power of the dose with carbon ions. This was interpreted as indicating that ad-3^{IR} mutations that are two-hit events with acute x-ray exposures were, in part, one-hit events with carbon-ion exposures. (auth)

12836 INDUCTION OF DIFFERENT CLASSES OF GENETIC EFFECTS IN YEAST USING HEAVY IONS. Nakai, S.; Mortimer, R. (Univ. of California, Berkeley). Radiat. Res., Suppl. 7, 172-81 (1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Results on the induction of a number of classes of genetic effects using radiations of different total linear energy transfer are presented. X rays, helium ions, carbon ions, and uv were used. For all effects studied, i.e., lethality, dominant lethality, mitotic segregation, allelic recombination, and reverse mutation, densely ionizing particles were more efficient than sparsely ionizing radiation. The maximum efficiency occurred in the total LET (LET_∞) region corresponding to 10 MeV/nucleon boron or carbon nuclei. Differences in the relation between RBE and LET_∞ occurred for the various effects, particularly in the height of the maximum and the slope with which the RBE decreases with LET_∞ values higher than the LET_∞ of maximum effectiveness. With respect to these differences, haploid inactivation and mutation appeared to be in one class, while diploid inactivation, dominant lethality, mitotic crossing-over, and allelic recombination were in another class. This might indicate differences in the molecular mechanism of induction of these effects. No pronounced differential effects of heavy compared to light ions were apparent for the induction of mitotic recombination in different intergenic or intragenic regions even though the relative dimensions differed by two orders of magnitude. The above findings are most easily explained by assuming that the nature and size of the targets for effects at different levels within the chromosome were similar or that the effects were mediated by a common diffusible intermediate. (auth)

12837 SURVIVAL, CHROMOSOME ABNORMALITIES, AND RECOVERY IN HEAVY-ION- AND X-IRRADIATED MAMMALIAN CELLS. Skarsgard, L. D.; Kihlman, B. A.; Parker, L.; Pujara, C. M.; Richardson, S. (Yale Univ., New Haven). Radiat. Res., Suppl. 7, 208-21(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Results are presented for survival of Chinese hamster cell colony-forming ability, chromosome damage, and recovery between two dose fractions for a wide range of accelerated heavy ions and for x rays. The dependence of the dose response on total LET (LET_∞) was found to be very similar for colony-forming ability (as judged by the final slope of the survival curve) and chromosome damage, supporting the hypothesis that the radiosensitive sites are the same for these two effects. The survival curves for heavy ions demonstrated a small but significant shoulder, persisting at least to a LET_∞ of 1890 MeV-cm^2/g, indicating the presence of accumulated sublethal damage at these high ionization densities. The recovery data showed that up to a LET_∞ of 443 MeV-cm^2/g some of this damage, at least, was reversible. The damage became irreversible, however, somewhere in the LET_∞ region between 400 and 1300 MeV-cm^2/g. (auth)

12838 RELATIVE BIOLOGICAL EFFECTIVENESS OF DIFFERENT TYPES OF IONIZING RADIATIONS: CYTOGENETIC EFFECTS IN MAIZE. Smith, Harold H. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res., Suppl. 7, 190-5(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

The frequency of yg_2 events in leaves grown from irradiated Yg_2/yg_2 maize seeds showed an essentially linear response to dose. Compared with 250-kVp x rays, the approximate relative biological effectiveness (RBE) of monoenergetic neutrons (0.43 to 14.7 MeV) was between 50 and 100, of muons (7 GeV) 0.76, of π^- mesons (8 GeV) 3.2, and of protons (28 GeV) 4.4. These results were considered in terms of dose average linear energy transfer (LET) and whether or not nuclear interactions took place. Application of microdosimetric concepts to this system indicated that the interphase chromosome was broken, to cause a yg_2 sector, when a single charged particle delivered an energy of approximately 93 keV or more to a spherical region of the cell nucleus that was approximately 1 μ in dia but proportional to nuclear size. (auth)

12839 GENETIC EFFECTS OF HIGH-LET RADIATIONS IN MICE. Searle, A. G.; Phillips, Rita J. S. (Medical Research Council, Harwell, Eng.). Radiat. Res., Suppl. 7, 294-303(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Two experiments are described in which hybrid male mice were exposed to various doses and intensities of fast neutron irradiation (mean energy 0.7 MeV), as well as to ^{60}Co γ radiation; spermatogonial mutation rates were obtained by use of the specific locus method. The dose-mutation relation appeared to be linear with chronic neutron exposures, and at low intensities the neutron-γ RBE for the induction of specific locus mutations was estimated to be about 23. A similar result was obtained with dominant visible mutations. Fast neutrons at high intensity (188 rads) gave a specific locus mutation frequency that was only one-eighth that from 214 rads at low intensity. Yields of other types of mutation were also very low after the high acute neutron dose. The results suggested that there was at most only a slight dose-rate effect with fast neutrons except at high doses, when there was a very marked falloff in yield from acute exposures, leading to a reversed dose-rate effect. At lower doses, fast neutrons seemed to be five to six times as effective as acute x irradiation for the induction of specific locus mutations in mouse spermatogonia. (auth)

12840 GENETIC AND ALLIED EFFECTS OF ALKYLATING AGENTS. Loveless, A. London, Butterworths, 1966. 284p. 77s. 6d.

Amongst topics discussed are: The radiomimetic effect; difference between effects of alkylating agents and X-rays; and interaction between alkylating agents and X-rays. (UK)

Health Physics and Safety

Refer also to abstracts 12422, 12429, 12455, 12463, 12473, 12474, 12535, 12779, 12780, 12829, 12890, 12891, 12895, 12903, 12907, 12933, and 13419.

12841 (AECL-2793) TABLES OF BETA DOSE DISTRIBUTIONS. Cross, William G. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov. 1967. 32p. Dep. CFSTI. CAN $1.00.

Tables are given of dose distributions near isotropic point and plane beta sources in air and water for 37 nuclides of importance in medicine and health physics. These were calculated from Spencer's dose distribution tables for monoenergetic electrons. A simple method is given for deriving dose distributions in other low-Z media. (auth)

12842 (BNWL-SA-1266) EFFECTIVE HALF-TIMES OF RADIONUCLIDES IN ALASKAN LICHENS AND ESKIMOS. Hanson, W. C.; Eberhardt, L. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1966]. Contract AT(45-1)-1830. 20p. (CONF-670503-2). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

The effective half-times of fallout radionuclides are essential factors in the analysis of radiation exposure to the biota. Arctic regions are now well known for the lichen-caribou (reindeer)-Eskimo (Lapp) food chains, which effectively concentrate significant amounts of fallout. To further describe the behavior of the important strontium and cesium radionuclides within these ecosystems, an attempt was made to measure loss rates in natural arctic communities in northern Alaska. Half-times of ^{85}Sr, ^{90}Sr, ^{134}Cs, and ^{137}Cs in Eskimos were studied at Anaktuvuk Pass, Alaska (68°10′ N., 151°46′ W.) during the period 1964 to 1966. The lichen studies consisted of applying measured amounts of radionuclides to natural communities and subsequently measuring the amount retained. Results are available for ^{85}Sr and ^{134}Cs observed for 2 years (1964 to 1966) and for ^{90}Sr and ^{137}Cs observed for 1 year (1965 to 1966). The effective half-time of ^{137}Cs in Eskimos was determined by replacement of caribou and other game in the normal diet of native residents by domestic meat. (auth)

12843 (NP-17131) REPARTITION D'UN MELANGE DE PRODUITS DE FISSION DANS UN MILIEU NATUREL. (Distribution of a Fission Product Mixture in a Natural Environment). Cadet, Jean (Grenoble Univ. (France). Faculte des Sciences). June 17, 1966. 46p. (In French). Dep.

Thesis.

The behavior of the fission products ^{144}Ce, ^{137}Cs, and ^{89}Sr in a water-sediment system was observed. In the first part of the study the importance of two parameters, height of the sediment and agitation of the water, were defined. The modifications caused by the introduction of a semiaquatic reed grass were studied. Comparison of the radioactivity of the water in the system with and without vegetation showed that in the hours following contamination the reed plants retained a significant fraction of the total radioactivity introduced. The behavior of Ce and Cs were comparable. They were localized preferentially in the roots. For the first 18 days no Sr could be detected in the plants, but between the 18th and 27th days there was a significant fixation in the tissues, particularly in the roots of the dead parts. (J.S.R.)

12844 (NP-17209) PLANNING FOR THE CONTROL OF RADIATION ACCIDENTS. Chadwick, Donald R.; Pecsok; Donald A.; Nelson, Donald J. Jr. (Public Health Service, Washington, D. C. Div. of Radiological Health). [nd]. 19p.

The prime objective in planning for the control of radiation released by accidents should be to prevent the accidents. A secondary objective is to provide an effective orderly action in event of accident. The technical facets of both objectives are well known for minor accidents and are not insurmountable for major accidents. To accomplish these objectives requires that responsibility be clearly established for planning and prompt handling of accidents. Based on the above rationale, the radiation source owner should play a major role in accident planning. Health agencies should make certain that adequate plans are made and should assist the radiation users in this objective. Where needed, assistance should be provided at time of accident in evaluation and control of radiation exposure particularly where contamination occurs beyond the property of the user. The public health agencies in most countries have legal responsibilities and much experience in disasters of major concern such as epidemics and threats to health posed by natural disaster situations. Actual experience has demonstrated the effectiveness of planning for the prevention and management of minor radiation accident situations. A basic problem in the case of major accidents is to be assured of effective planning, including clear delineation of areas of responsibilities. (auth)

12845 (ORNL-4215) ON THE RELATIONSHIP OF COLLISION THEORY TO THE INTERPRETATION OF RELATIVE BIOLOGICAL EFFECTIVENESS. Turner, J. E.; Hollister, Hal (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 11p. Dep. CFSTI.

Relative biological effectiveness (RBE) is observed to depend upon the physical characteristics of radiation and on the biological effect or end point being studied. The quantity most often used to describe the quality of radiation is its linear energy transfer (LET), or, in the case of uncharged radiation, the LET of charged secondary particles. The quantum mechanical collision theory was applied to see which physical quantities are relevant in the sense that RBE depends on them, biological factors being kept fixed. By means of successive Born approximations it is shown that the velocity and charge of a heavy charged particle are ultimately the only physical quantities that are needed to describe RBE in terms of the properties of the incident radiation, and these two quantities enter the description of RBE in a combination other than that of the LET function. An experimental test of the practical significance of these results is suggested. (auth)

12846 (ORNL-TM-2079) CALCULATIONS OF NEUTRON FLUENCE-TO-KERMA FACTORS FOR THE HUMAN BODY. Ritts, J. J.; Solomito, E.; Stevens, P. N. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 29p. Dep. CFSTI.

Fluence-to-kerma factors (where fluence is the time-integrated neutron flux and kerma is equal to the total kinetic energy released in materials by charged particles resulting from direct neutron interaction per unit mass of the irradiated medium) were calculated at discrete neutron energies from 0.045 eV to 15 MeV for various compositions in the human body tissue, muscle, bone, lung, brain, red marrow, and the "standard man" composition. The calculations applied the latest cross sections for the 11 most common elements in man. A number of reactions were included that were not considered in previously reported work, namely, an anisotropic elastic-scattering correction, inelastic scattering, (n,2n) reactions, (n, charged particle) reactions, and beta or positron emissions from these reactions. These calculations are improvements in the 10-15 MeV and 2-100 eV ranges over the neutron first-collision flux-to-dose conversion factors previously reported by Snyder. (auth)

12847 (CEA-tr-R-1906) PROBLEME DE LA DECONTAMINATION DES RADIOISOTOPES DE CERTAINS REPRESENTANTS D'INVERTEBRES AQUATIQUES. (Radioisotope Decontamination of Certain Representative Aquatic Invertebrates). Getsova, A. B. Translated into French from Dokl. Akad. Nauk SSSR, 133: 459-61 (1960). 11p. (In French). Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Mosquito larvae (Culex pipiens pipiens), caddis flies (Halesus interpunctatus), and molluscs (Aplexa hypnorum) were introduced into water containing ^{144}Ce, ^{137}Cs, ^{106}Ru, and ^{90}Sr. The mosquito larvae were removed to pure water after the third day; the caddis flies and molluscs were transferred after the eighth day. Following removal to pure water, the radioisotope content of the organisms was determined at intervals. The results are tabulated. Decontamination was accomplished by EDTA in all cases with the exception of ^{90}Sr. (J.S.R.)

12848 (JPRS-42730, pp 59-65) MEASUREMENT OF TISSUE DOSES OF COSMIC RADIATION BY NUCLEAR EMULSIONS. Bogomolov, K. S.; Veprik, Ya. M.; Deberdeev, M. Yu.; Kovalev, E. E.; Litvinova, E. G.; Romanovskaya, K. M.; Sirotinskaya, A. A.; Skvortsov, S. S.; Skuredin, V. P.; Smirennyy, L. N. Translated from Kosm. Biol. Med., 1: No. 3, 39-43(1967).

Methods for measuring the tissue dose of ionizing radiations with the aid of nuclear emulsions are discussed. Emulsions differing in their sensitivity, with different physical development techniques, were used. Measurements made aboard Kosmos satellites are described. (auth)

12849 EXAMINATION AND RATING OF THE VISION OF PERSONS EXPOSED TO MICROWAVE EFFECTS (WITH SPECIAL ATTENTION TO EYE LENS CAPACITY). Zydecki, S. Lek. Wojsk., No. 2, 124-9(1967). (In Polish).

Industrial hygiene and safety procedures to be observed during the operation of electromagnetic field generators in military institutions and units, issued to protect the health of workers exposed to microwave radiation are discussed. Medical examinations (including eye tests) prior to employment, and periodic reexaminations for all persons exposed to microwaves are recommended. Ophthalmological examinations are mandatory for candidates of radio engineering schools and prospective employees at military facilities operating microwave generating equipment. Periodic eye examinations are made at least once a year. Control examinations take place whenever an eye ailment is suspected, or when the worker himself reports such a complaint. The importance of the preliminary eye examination, that ought to include

tests with slit lamp, eye speculum, skiascope, and pupil dilating drugs such as homatropine, is stressed. Test results yield four classifications reflecting suitability for work with microwaves; qualified (A), qualified with limitations (B), temporarily disqualified (C), and permanently disqualified (D). Persons in category B cannot operate equipment with a power density greater than 10 microwatt/cm^2, and cannot be admitted as students to radio engineering schools. Persons in category C must not be exposed for longer than six months to microwaves; at the end of this time they must be reclassified as Category A, or B, or D. Eye examination for microwave damage follows routine opthalmological procedures. Since eye lens photography is still technically unsatisfactory, the substitution of five lens transparency grades (high to low) according to various medical symptoms is suggested. Grades one and two would place a person in category A, grade three in category B, and grades four and five in D. These findings are entered on the inside cover of the health booklets of soldiers and civilian employees exposed to microwaves but are coded to keep them from being known to the examinee. A more detailed record of the eye examinations is to be kept in the medical office files. (ATD)

12850 DECONTAMINATION FOLLOWING EXTERNAL IRRADIATION BY RADIOACTIVE SUBSTANCES. Strambi, E. Terapia (Turin), 51: No. 380, 145-53(Aug. 1966). (In Italian). (RT/PROT-(67)5).

The physiopathology of the skin is briefly reviewed. Substances and methods used for removal of radioactive materials from cutaneous tissues and mucosa are discussed. Criteria that serve as useful guidelines for the application of the methods and for medicolegal evaluation of data are examined. (tr-auth)

12851 CONTINUOUS COUNTING OF ^{32}P FROM TRANSPLANTED RAT TUMOURS, AND THE EFFECTS OF RADIOSENSITISERS AND RADIOPROTECTIVE AGENTS. Calcutt, G.; Bullen, M. A.; Marshall, D. H.; Godden, T. J. (Mount Vernon Hospital, Northwood, Eng. Bristol General Hospital, Eng.). Brit. J. Cancer, 21: 438-47(June 1967).

The physical background and instrumentation for the continuous counting of ^{32}P from tumors are described. The application of these methods in the case of two transplantable tumors in August rats is outlined. The effects of a number of physiologically important agents and some known radioprotective or radiosensitising agents on ^{32}P counting rates were examined. The findings are discussed. (auth)

12852 RADIUM EMANATIONS AND FOEHN DISEASE. Schroecksnadel, H. (Univ., Innsbruck). Wien. Klin. Wochensch., 77: 1009-12(Dec. 24, 1965). (In German).

Some relations of the increased Rn concentrations found in the lower atmosphere during the foehn are discussed in terms of its biometeorological effects. So far, all of the data that are available to demonstrate any relation between the foehn and the radioactivity of the atmosphere are insufficient. According to measurements taken during foehn conditions, the atmospheric concentration of Rn is only $^1/_{10}$ the maximum permissible concentration of 10 pCi/l. In addition, many of the symptoms considered to result from exposure to foehn conditions are very similar to those observed after various types of treatments, such as warm baths and similar balneological procedures. It was concluded that much more study will be required to definitely establish the radiobiological effects of the foehn. (BBB)

12853 STRONTIUM-90 AND LEUKEMIA. Loutit, J. F. (Atomic Energy Research Establishment, Harwell, Eng.). Sci. Basis Med., Ann. Rev., 340: 55(1967).

Evidence relating to the carcinogenic and leukemogenic action of ^{90}Sr is reviewed, with 40 references, and neoplasias arising from ^{90}Sr are compared with those from other radionuclides and ionizing radiation sources. The carcinogenic effect of Ra in producing bone sarcomata was confirmed many years ago in man and experimental animals; consequently, on the basis of chemical and metabolic similarities of Ra and ^{90}Sr, it was forecast that osteosarcoma should be the limiting hazard in the case of ^{90}Sr. The human experience with Ra suggests no hazard owing to leukemia, but the radiation from Ra and its daughter products are mainly α particles of poor penetration, that may largely fail to irradiate active bone marrow in the interstices of trabecular bone. Strontium-90 on the other hand, is a β-emitter with considerably more penetrating radiation. In adult trabecular bone the mean dose would be 0.55 rad/yr to bone marrow from 1 μCi deposited in the skeleton. Late effects of radiation in human subjects are considered on the basis of the survivors of the atomic bombing of Hiroshima and Nagasaki and cases of ankylosing spondylitis treated with x rays. Leukemia was the predominant sequel in both instances. Leukemias, mainly lymphoid, were recorded in rats following administration of ^{90}Sr. The absence of leukemia of myelogenous type in man and experimental animals contaminated with bone-seeking radioisotopes tended to divert attention from the changes of leukemogenesis. However, pigs given daily 25 or 125 pCi of ^{90}Sr in their rations died, several of myelogenous leukemia and others of lymphosarcoma. Dogs given repeated injections of ^{90}Sr also died from myelogenous leukemia and lymphosarcoma or reticulum cell sarcoma. There are some human data from subjects given massive doses of high intensity radiation that suggest that the subsequent incidence of certain forms of leukemia is compatible with a linear relation to dose. Thus, leukemia might determine the dose limits, now arbitrarily judged to be acceptable, rather than osteosarcoma as formerly. Bone tumors have not yet been recorded in man from ^{90}Sr. In experimental animals the induction seems to depend on a multiplicity of events. (BBB)

12854 USE OF SOIL CONTAMINATED WITH ^{90}Sr FOR SEED PRODUCTION. Evans, E. J.; Dekker, A. J. (Soil Research Inst., Ottawa, Ont.). Can. J. Plant Sci., 47: 319-20(1967).

It was demonstrated that soil no longer suitable for production of feed crops because of contamination with ^{90}Sr may be utilized for seed production. Seed of 4 crops (oats, Avena sativa; barley, Hordeum vulgare; wheat, Triticum vulgare; and soybean, Glycine max) which were heavily contaminated as a result of their having been grown on contaminated soil in a previous experiment were grown in duplicate to maturity on inactive soils. Only a small part of the original radioactivity in the seed was found in the second generation straw, and none was found in the second generation seed. A higher proportion of ^{90}Y was found in the soybean straw than in the straw of the cereals. With soybean, a radioautograph of the plant showed that the ^{90}Sr moved slightly from the cotyledons to the hypocotyl, but movement into the epicotyl could not be detected. Most of the radioactivity remained in the cotyledons. It was concluded that it would be possible to utilize soil contaminated with ^{90}Sr for the production of seed with reasonable certainty that the second generation seed grown on uncontaminated soil would be free of ^{90}Sr. (BBB)

12855 HIGH SENSITIVITY SHADOW-SHIELD WHOLE BODY MONITOR WITH SCANNING-BED AND TILTING CHAIR GEOMETRIES, INCORPORATED IN A MOBILE LABORATORY. Boddy, Keith (Scottish Research Reactor Centre, Glasgow). Brit. J. Radiol., 40: 631-7(Aug. 1967).

The development of a shadow-shield, whole-body monitor of high sensitivity is described. The monitor is installed in a mobile laboratory and is intended for medical research in collaboration with Scottish hospitals. Normally scanning-bed geometry is used but, by modification of the shield, a tilting-chair geometry is achieved to accommodate patients who cannot lie flat. It is shown that the performance of the monitor is better than most conventional steel-room monitors in Britain, while the capital cost as a static monitor, with a 100-channel analyzer, is only about £6,500. Redistribution effects are briefly described and have not exceeded ±7 per cent in patients following the oral administration of ^{59}Fe. (auth)

12856 THE ^{90}Sr CONTAMINATION OF SOIL AND PLANTS ON THE TERRITORY OF THE G.D.R. IN 1964 AND 1965. Scheel, H.; Kunert, J.; Bose, H. (Staatliche Zentrale fuer Strahlenschutz Berlin). Kernenergie, 10: 255-8(Aug. 1967). (In German).

In 1964 and 1965 the ^{90}Sr contamination of soil was on the average 30 to 35 nCi/m^2. The determination of the ^{90}Sr content of various plants and plant parts showed that the decrease of ^{90}Sr contamination was not in accordance with the decrease of the ^{90}Sr fallout. Whereas in 1965 the ^{90}Sr fallout in the various growth periods was 18 to 24% of that in 1963, the ^{90}Sr content of dried plant materials had only decreased to 40 to 87%. The decrease of the sunshine units was more pronounced (22 to 81%). Estimations showed that since 1963 the ratio of surface contamination to total contamination permanently decreased. Furthermore, the ^{90}Sr retention during growth period was between 4 and 21% for the investigated plants. The uptake from soil was estimated to be 0.1% for potato tubers and about 1% for the other plants. (auth)

12857 INTERACTIONS ABOVE 10 GeV. Cowan, Frederick P. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-gen-16. Radiat. Res., Suppl. 7, 1-9(1967). (BNL-9474).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7-10, 1965. See CONF-650924-(Suppl.).

An attempt to classify and describe the interactions occurring in the GeV energy region with emphasis on energies greater than 10 GeV is presented. From a dosimetric point of view, the situation is favorable, since no basically different processes are known or expected above 10 GeV as compared with those in the 1- to 10-GeV region. On the other hand, dosimetry in this region of ultrahigh energy is made difficult by the long mean free paths of the particles

concerned and the complicated patterns of decay and production. Thus, the composition of radiation, the value of the absorbed dose, and the applicable RBE/QF values are dependent not only on the nature of the primaries involved but also on the previously encountered material and geometric factors. Although difficult, these problems are being successfully attacked from both the theoretical and experimental points of view. (auth)

12858 PHYSICAL CHARACTERISTICS OF SOLAR FLARES. Curtis, S. B. (Boeing Co., Seattle). Radiat. Res., Suppl. 7, 38-42(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Radiation hazards from solar particle events are discussed. Calculations were made of doses to astronauts behind various spherical aluminum shielding thicknesses in spacecraft operating outside of the earth's magnetosphere for most of the mission time. The depth-dose dependence was found to result in much larger body surface doses than in organ doses. It was concluded from the dE/dx spectra that with thin shielding the highly ionizing component would be large enough to cause serious accumulation of radiation injuries during long missions. (M.M.B.)

12859 DOSIMETRY OF PROTON BEAMS USING SMALL SILICON DIODES. Koehler, A. M. (Harvard Univ., Cambridge, Mass.). Radiat. Res., Suppl. 7, 53-63(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Silicon diodes intended for electronic applications were tested as radiation dosimeters in proton beams. Effects of dose rate, measuring circuit impedance, radiation damage, and proton energy were investigated. The small size of the diodes made them nearly ideal for exploring the depth-dose distribution of small well-collimated beams. A measuring circuit of sufficiently low input impedance must be used. Pre-exposure to massive doses of radiation virtually eliminated changes in sensitivity during subsequent measurements at lower intensities. Response was adequately independent of proton energy for many applications, although an unexplained discrepancy with nitrogen ion chamber measurements existed. (auth)

12860 PHYSIOLOGICAL EFFECTS OF SPACE CABIN ATMOSPHERES. Roth, E. M. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Radiat. Res., Suppl. 7, 413-22(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Physiological criteria for the selection of space cabin atmospheres are reviewed. Emphasis is placed on the implication of these factors on engineering constraints and radiobiological considerations. The current operational atmospheres with 5 psi of 100% oxygen do not appear to significantly affect the radiation hazard within the cabin. Analysis of the complex man–machine interactions and engineering tradeoffs suggests that the selection of the ideal space cabin atmosphere must be specific for each space mission in question. (auth)

12861 FRESHWATER FISH IN A NUCLEAR DISASTER. Shinn, Alvin F. (Oak Ridge National Lab., Tenn.). pp 51-5 of Proceedings of the Commercial Fish Farming Conference, Texas A and M University, College Station, Texas, February 1–2, 1967. College Station, Tex., Texas A and M University, 1967. See CONF-670208.

An estimate of the national food supply available in the event of a nuclear attack is presented. It is pointed out that widespread production of freshwater fish in inland waters could be an important source of excellent protein. It is estimated that four billion pounds of whole raw fish would supply 80 days of daily 10 g protein supplements for the entire United States population. Levels of radioisotopes from fallout in fish are discussed; it appears that fallout contamination does not severely limit fish production or consumption. (H.L.W.)

12862 THE IONISING RADIATIONS (UNSEALED RADIOACTIVE SUBSTANCES) REGULATIONS 196. (DRAFT). London, Her Majesty's Stationery Office, 1967. 31p. 2s. 9d.

Section headings are as follows: Interpretation and general; administration, notifications, and records; basic principles of protection; radiological supervision; medical supervision; arrangement of premises and plant; personal protection; organization of work; monitoring and measures to deal with contamination. Schedules are included for maximum permissible radiation doses, maximum permissible levels of contamination and method of assessment; classification of radionuclides. (UK)

12863 EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD. ANNEX A. PROVISIONS CONCERNING DANGEROUS SUBSTANCES AND ARTICLES. ANNEX B. PROVISIONS CONCERNING TRANSPORT EQUIPMENT AND TRANSPORT OPERATIONS. London, Her Majesty's Stationery Office, 1967. 370p. 27s. 6d.

Sections are included on radioactive substances comprising the text agreed at the 19th Session of Working Party No. 15 of the International Transport Committee of the Economic Commission for Europe. (UK)

Medicine

Refer also to abstracts 12535, 12583, 12780, 12785, 12797, 12833, 12851, 12853, 12855, 12900, 12910, 12914, and 12934.

12864 (ORO–2401-10) RADIOISOTOPE STUDIES UTILIZING A LOW LEVEL WHOLE BODY COUNTER. Progress Report, 1967. Brill, A. B. (Vanderbilt Univ., Nashville, Tenn.). Oct. 26, 1967. Contract AT(40-1)-2401. 61p. Dep. CFSTI.

The development of a low-level whole-body radiation counting system for use in clinical studies is described. The system has computer-controlled dual scanning crystals, a high energy, high resolution honeycomb collimator, a magnetic tape data storage system, cameras for black and white and color pictures of scans, and computer analysis of counting data. A procedure is described for the simultaneous measurement of K, Na, and chloride body spaces in man by isotope dilution methods using ^{42}K, ^{24}Na, and ^{82}Br. Results are reported from studies on the effect of mg on K retention in man and a preliminary study on the incorporation of ^{75}Se-selenomethionine and ^{35}S-methionine into human lipoproteins. The decay scheme of ^{75}Se was investigated for use in γ dosimetric calculations. Preliminary studies were carried out using point sources of ^{131}I and ^{99}Tc in leucite phantoms in water to test the performance of a single-hole collimated detector for the external measurement of activity from tracer doses of radioisotopes. Procedures are described that were used to: measure blood flow in patients with hypertension using Na ^{125}I as a tracer; the calibration of a 3-crystal ring counter for measurements of ^{131}I uptake in thyroid gland; investigations on the use of stable ^{58}Fe and neutron activation analysis of biological samples for clinical studies on Fe absorption; and the development of high-resolution Li-drifted Ge semiconductor detectors for use in neutron activation analysis. (C.H.)

12865 STUDIES ON TRANSPLANTATION OF BONE MARROW AND SPLEEN CELLS. Munakata, Koji (Nagoya Univ., Japan). Nagoya J. Med. Sci., 29: No. 2, 129-38(Dec. 1966).

The mechanisms of protection against radiation death by bone marrow transplantation and transplantation immunity using bone marrow cells and spleen cells were studied. Hematological and histological findings on blood forming organ in lethally irradiated mice with and without bone marrow transplantation revealed that the essential feature of prevention of acute radiation death by bone marrow transplantation is the rapid replacement of the destroyed marrow by transplanted normal hematopoietic tissue. Optimal 30 days survival was seen with doses of about 1×10^5 bone marrow cells in heterologous transplantation, whereas in homologous approximately the same range of survival was obtained with doses of about 1×10^7 cells. Therefore, it can be said that the optimum dose of heterologous bone marrow cells that will protect lethally irradiated mice is about 10 times that of homologous. Imprints of bone marrow and spleen from x-irradiated mice given rat bone marrow were stained for alkaline phosphatase-positive cells (rat bone marrow cells). With increase in x ray dose to mice, rat bone marrow cells persisted longer in mice, namely 3 to 4 days after 400 R and 8 to 10 days after 800 R. When the dose was increased up to 950 R, approximately 30 to 40% of donor cells were detected even after 8 days. These data confirmed the repopulation theory as the mechanism of action of the injected bone marrow. Infusion of various doses of splenic cells of adult rats (2.5×10^7, 5×10^7, and 2×10^8 nucleated cells) could not keep lethally irradiated mice alive. However, when infused with 2.5×10^7 of splenic cells from 4-hr newborn rats, 90% of lethally irradiated mice survived over 60 days, yet no such protective effect was observed when the cells used were from 72-hr infant rats. These results suggest that transplanted antibody-forming cells in spleen from newborn rats acquired immunologic tolerance versus host. (NSA of Japan)

12866 ACCIDENTAL OVERDOSAGE WITH RADIOPHOSPHORUS: THERAPY BY INDUCED PHOSPHATE DIURESIS. Cobau, Charles D. (Toledo Clinic, Ohio); Simons, Charles S.; Meyers, Muriel C. Amer. J. Med. Sci., 254: 451-63(Oct. 1967).

For treatment of essential thrombocytosis a young woman was given 3.5 mCi of ^{32}P and eight months later, because of still elevated platelet levels, another dose of carrier-free ^{32}P, calculated to be 4.05 mCi, was given orally. On the seventh day following treatment, it was discovered that an error was made in the labeled

date of assay of the isotope. Using the corrected date, recalculation showed that the patient actually had received 16.2 mCi. On the ninth post-treatment day, an attempt was made to induce increased excretion of the remaining isotope. The program included 5 g of phosphates by mouth daily as the buffered Na salts, 540 mg of Ca as the gluconate daily by slow intravenous infusion, and 200 U of parathyroid extract intramuscularly every 6 hours. This program was continued for 18 days. Throughout the entire course, the patient remained free of symptoms directly or indirectly attributable to ^{32}P. Analysis of the excretion of ^{32}P showed a decrease of the effective half-life from 11.2 to 4.8 days, equivalent to a seven-fold increase in the rate of isotope excretion. As a result, the anticipated exposure (954 rad) to the bone marrow was reduced by 38%. Earlier institution of the program of phosphate diuresis would probably have resulted in more effective reduction in marrow irradiation dose. By the 165th day following exposure the patient had recovered fully from the immediate hematologic effects of the excessive radiation exposure. (BBB)

12867 PROCESSES AND REACTIONS OF THE RADIOBIOLOGICAL EFFECT AND THEIR MODIFICATION BY SUBSTANCES IN THE BODY. Langendorff, H. (Univ., Freiberg i B.). Ber. Phys.-Med. Ges. Wuerzburg, 72: 27-39(1966). (In German).

The theories of what types and mechanisms of energy transfer take place during irradiation of various substances and organisms are reviewed, and their significance relative to damage produced is discussed. The chemical events following irradiation of H_2O, and formation of various radicals and peroxides are described. The effects of low oxygen tension, cysteamine, aminomercaptoheptane, 5-hydroxytryptamine, estrogens, penicillamine, etc. on radiosensitivity are discussed. The possible role of cellular coenzymes is described briefly. The uses of these substances to modify irradiation effects are reviewed. (BBB)

12868 CHROMOSOME ABERRATIONS IN LEUCOCYTES IN OLDER SURVIVORS OF THE ATOMIC BOMBINGS OF HIROSHIMA AND NAGASAKI. Bloom, Arthur D.; Neriishi, Shotaro; Awa, Akio A.; Honda, Takeo; Archer, Philip G. (Atomic Bomb Casualty Commission, Hiroshima). Lancet, 2: 802-5(Oct. 14, 1967).

In a preliminary cytogenetic survey of the survivors of the atomic bombings of Hiroshima and Nagasaki, complex chromosomal rearrangements were detected in 34% of heavily exposed persons. The present report gives the findings in survivors and controls who were over 30 yr of age in 1945. Both the frequencies and the predominant types of aberrations differed from those found previously in the younger subjects. Of 157 persons examined cytogenetically, 22 consisted of matched pairs studied in Nagasaki and 55 pairs in Hiroshima. Of the 77 heavily exposed patients, 47 (61%) had one or more complex chromosomal abnormalities (dicentric, ring, fragment, translocation, or inversion). In contrast, 13 (16.3%) of the 80 controls had similar aberrations. The frequency of the aberrations in the 6778 cells of exposed persons was 1.5%; in the 7188 cells of controls, 0.3%. In terms of the proportion of affected persons or the proportion of abnormal cells, the differences between heavily exposed groups and control groups were statistically highly significant. By far the commonest type of abnormality was translocation. Unlike the findings in the younger, previously investigated survivors, translocations and pericentric inversions predominated. Furthermore, the presence of what may be clones of cells with stable aberrations supports the idea of in vivo cell division of at least some cells of the pool of immunologically competent lymphocytes. (BBB)

12869 HUMAN BONE AND BONE MARROW HOMOGRAFTING BY ADAPTATION METHOD. Jankay, L.; Samp, B.; Ascher, G. (Veterans Administration Hospital, Long Beach, Calif.). Bibl. Haematol., 23: 243-7(1965).

A new method of bone marrow transplantation that may be used to restore hematopoiesis in otherwise lethally irradiated recipients was developed; it depended upon adaptation of the donor cells to the recipient's blood. Fresh specimens of bone spicules with marrow were obtained from the iliac crest or from vertebrae during orthopedic surgery. These fragments were cut into about 2-mm^3 fragments and rinsed in balanced salt solution and then placed into a dialysing and circulating culture chamber. Heparinized whole blood (15 ml) of the recipient was added to the culture that served as culture medium. The blood in the culture was kept in constant motion to ensure suspension of the blood cells. Oxygen was supplied to the blood by membrane oxygenation. The culture with the blood was dialyzed during the entire time of cultivation. Cultivation was terminated five days later and the fragments were removed from the blood and washed in balanced salt solution. The cultured graft fragments were then transplanted into the recipient subcutaneously with the aid of a trocar. No immunosuppressive agents were used. Eight days after implantation vascularization took place. At this time the patient received ^{59}Fe intravenously; scanning was done to check the uptake of this label by the erythroid elements of the homograft. Two weeks after implantation the homograft was excised and hematopoiesis demonstrated histologically in the biopsy. Photoscans over the area of grafts showed increases in ^{59}Fe uptake as was expected. Results indicated the acceptance of the homograft by the recipient and demonstrated the feasibility of adapting homologous bone and bone marrow for successful transplantation. No explanation is offered for the lack of immune rejection of the transplants. (BBB)

12870 PRINCIPLES AND FUNCTION OF THE PANORAMIX. Guzman, Cesar A. (Eastman Dental Center, Rochester, N. Y.). Oral Surg., Oral Med., Oral Pathol., 24: 196-205(Aug. 1967).

Use of an intraoral x-ray source for dental radiography is described, and the reduction of radiation exposure of the patient as compared with the use of conventional techniques is pointed out. Radiation dose measurements taken with the machine described, operated at 52.5 KV, 1 ma, and 0.3 sec exposure time, are given. In the palatal region (1.2 cm distance from the anode), an average reading of 530 mR was obtained. For the surface of the tongue, with the tube angulated for an upper exposure, the average dose at 2.5 cm from the anode was 380 mR. For the inner epithelial tissue of the cheek (measured at 3.0 cm from the target), the average dose was 260 mR. For the lingual aspect of the upper incisors at 4.0 cm from the target, the average dose was 130 mR. Exit dose measurements, made at the surface of the skin, with the tube in position for an upper jaw exposure, showed 8 mR for the molar area, 14 mR for the premolar area, and 18.5 mR for the incisor area. These gradient readings in exit dose agree with the absorption-thickness relation of these areas and their photographic densities, as seen in Panoramix roentgenograms. The radiation production rate for a tube operated at 52.5 KV and 1 ma was 1.5 R/sec, measured at 1.0 cm from the anode. At a setting of 60 KV and 0.5 ma, the rate of radiation was 1.18 R/sec. Previous measurements are also reported for the average skin dose of the thyroid gland, lateral orbital wall, and angle of the mandible obtained with 2 Panoramix exposures as compared with a complete mouth periapical x-ray survey using 14 film exposures. The thyroid gland received an average dose of 45 mR with conventional radiographs and 26 mR with upper and lower Panoramix radiographs. The lateral orbital wall received 265 mR from the exposure of 14 periapical films, compared to 23 mR from the exposure of 2 Panoramix films. The angle of the mandible received a 350 mR dose from 14 periapical exposures, against 171 mR from 2 Panoramix exposures. (BBB)

12871 THREE-DIMENSIONAL COMPUTER READ-OUT OF RADIOISOTOPE SCAN DATA. MacIntyre, William J.; Christie, James H.; Curtis, Gretchen S. (Western Reserve Univ., Cleveland). Radiology, 90: 22-6(Jan. 1968).

A method of producing a three-dimensional representation of conventional scanning data with an IBM 1620 computer and a Model 565 Cal-Comp plotter was illustrated. Spatial distribution of the radioactive material in the organ was retained and viewed without such aids as color variations or contour lines to simulate variations in intensity. (auth)

12872 PLANE SPREAD-FUNCTIONS IN RADIOISOTOPE SCANNING. Rao, U. V. Gopala; Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore). Radiology, 90: 14-21 (Jan. 1968).

The concept of a plane spread-function as a means to overcome variation of resolution with distance from the collimator face is proposed. A plane spread-function is defined as the response of a collimator obtained when an infinitely long plane of uniformly distributed radioactivity, placed parallel to the long axis of the collimator is moved in a direction perpendicular to the collimator axis. A modified plane spread-function is defined as a plane spread-function in which the plane of radioactivity is limited to a known width on either side of the focal depth. The significance of the conversion of modified plane spread-functions into their one-dimensional Fourier transform is discussed. As a means to overcome the problem of variation of sensitivity with distance from collimator face, the concept of volume response was proposed as an alternative to the conventional plane source response. Volume response is defined as the number of counts recorded in a unit interval of time when a volume source of radioactivity containing one microcurie per square centimeter of cross-sectional area is held at right angles to the long axis of the collimator, the volume source being of infinite dimensions at right angles to the collimator axis but limited to the average width of the organ of interest along the line axis of the collimator. (E.R.B.)

12873 MECHANISMS OF ACTION OF RADIOTHERAPY AND CHEMOTHERAPEUTIC ADJUVANTS. Vermund, H.; Gollin, F. F. (Univ. of Wisconsin, Madison). Cancer, 21: 58-76(Jan. 1968).

A review of the rationale for application of combined radiation and chemotherapy in the treatment of certain malignant tumors is presented. The mechanisms of action of ionizing radiations and many of the commonly employed chemotherapeutic agents are intimately related to the nucleic acid metabolism of proliferating cells. Modification of the DNA-molecule by certain chemotherapeutic agents results in sensitization of the cell to subsequent irradiation. Reduction in the total number of malignant cells by preirradiation chemotherapy facilitates subsequent radiotherapy of advanced tumors. Certain chemotherapeutic antitumor agents exert a beneficial effect by restraining the growth of distant metastases that often escape clinical detection. (auth)

12874 PRELIMINARY OBSERVATIONS ON THE USE OF RADIOACTIVE ^{32}P IN DIAGNOSING LYMPHATIC METASTASIS IN PENIAL CANCER. Ch'en, Hung-kuang; Shih, Hsi-en; Liu, Yao-ch'en; Liu, Shao-wu (Tientsin Medical Coll., China). Chung Hua Wai K'o Tsa Chih, 12: 840-2(Sept, 1964). (In Chinese).

Phosphorus-32 was used in diagnosing lymphatic metastasis of carcinoma of the penis and the uptake of ^{32}P in the inguinal glands was used for the differentiation between the metastasis of cancer and inflammatory reactions. In 12 of the 14 cases tested, the ^{32}P uptake corresponded to the results of the pathological examinations, and the other two were false positive and false negative. Based on the data of these 14 cases, it was temporarily decided that metastasis was probable when ^{32}P uptake was over 50% and those less than 50% were inflammatory reactions. (JPRS)

12875 INVESTIGATIONS ON THE EFFECTS OF RADIOPROTECTIVE SUBSTANCES ON THE FRONT EYE SECTION OF THE RABBIT AFTER THE ACTION OF FAST NEUTRONS. Straub, W.; Graul, E. H.; Ruether, W.; Neubauer, H.; Jacobi, K. W.; Krueger, H. (Univ., Marburg, Ger.). Arch. Klin. Exp. Ophthalmol., 169: 1-11(1966). (In German).

Among the chemical radioprotective drugs serotonin and cysteamine proved to be especially effective in treating ^{60}Co-γ- or x-ray damages. In experiments on 55 rabbits serotonin, cysteamine and a combination of serotonin, cysteamine and vitamin B_6, AMP, and ATP were examined for their radioprotective effectiveness on the anterior segment of the left eyes after radiation with 930 rad 15 MeV-neutrons. The right eyes of the animals received about 13% of this dose and additionally 900 R ^{60}Co-γ-rays. During an observation period of 210 days cataract, conjunctivitis, blepharitis and keratitis were observed. For both kinds of rays a protective effect could be determined. For example, in the group of the untreated left eyes the alterations were earlier and stronger in evidence, compared with the treated groups. So it seems, that a protection of the eye against 15 MeV-neutron radiation and ^{60}Co-γ-radiation is possible. (auth)

12876 RADIOTHERAPY OF PITUITARY CHROMOPHOBE ADENOMAS. AN EVALUATION OF INDICATION, TECHNIC, AND RESULT. Chang, Chu Huai; Pool, J. Lawrence (Columbia Univ., New York. Columbia-Presbyterian Medical Center, New York). Radiology, 89: 1005-16(Dec. 1967).

The results of radiotherapy for 301 cases of pituitary chromophobe adenomas at the Neurological Institute and the Presbyterian Hospital of the Columbia-Presbyterian Medical Center from 1937 through 1964 are presented. In 149 cases radiotherapy alone was given; in 77 cases primary radiotherapy was followed by surgery; and in 75 cases initial surgery was followed by radiotherapy. Over the years three different radiotherapy techniques were used: multiple-course, low-dose; multiple-course, medium-dose; and single-course, high-dose. Successful improvement in vision was obtained in about 35 per cent of the cases in the multiple-course low-dose group, in about 50 per cent in the multiple-course medium-dose group, in about 56 per cent in the single course 3,000 to 3,900 R/three to four weeks tumor dose group, and in about 78 per cent in the single-course 4000 to 5,000 R/four to five weeks tumor dose group. The improvement in results corresponds in general with the increase of radiation dosage within the dose range that was used in our patients. The indications for radiotherapy and for surgery are discussed. We believe that irradiation is the choice for initial treatment unless the tumor is large, obviously cystic, and/or the vision is surely compromised. In such cases, neurosurgical decompression should first be done, followed by radiotherapy. Late radiation complications in the form of radionecrosis of the calvarium, abnormal changes in local blood vessels, and malignant transformation of an adenoma were encountered in a few cases many years after multiple courses of orthovoltage radiotherapy. (auth)

12877 TREATMENT OF RADIATION SICKNESS. Stoll, Basil A. (Chester Beatty Research Inst., London). Brit. Med. J., 2: 434-5(Aug. 12, 1967).

Criteria for demonstration of effectiveness of drugs for treating radiation sickness in clinical trials are discussed. Radiation sickness comprises a complex of symptoms, of which each symptom must be considered separately for response. Vomiting is the easiest of all to control, nausea less so, while anorexia and lassitude are the most resistant to treatment. The degree of relief of each symptom, partial or complete, must be specified. Whereas abolition of vomiting can be measured quantitatively, the complete abolition of lassitude and anorexia is rarely admitted by patients. In view of the variation of degree of radiation sickness with the site of irradiation, size of field, and daily dose, drugs are best compared on the basis of their efficacy in relation to one specific technique. Postoperative breast irradiation is well suited to this purpose. Placebo tablets give a surprisingly high proportion of relief of symptoms. They relieve vomiting in over 50% of cases as a whole, although the proportion relieved is much smaller when the abdomen or pelvis is being irradiated. Thus the proportion of patients receiving treatment to this area must be equated to compare any two series. Such test results should demonstrate completeness of relief achieved, relief of anorexia and lassitude, and relief of symptoms following abdominal or pelvic irradiation. All these symptoms are the most resistant to relief. Only by the detailed analysis of such criteria in large series of cases will the value of drugs in radiation sickness be clarified. (BBB)

12878 MEDICAL RESEARCH COUNCIL RADIATION RESEARCH AT THE HAMMERSMITH HOSPITAL: RADIATION SOURCES AND RADIOISOTOPES. Vonberg, D. D. (Hammersmith Hospital, London). Proc. Roy. Soc. Med., 60: 784(Aug. 1967).

Discussion is presented on the use of a cyclotron to study the following: short-lived and neutron-deficient isotopes not available from reactors, fast neutrons for radiotherapy, and radiobiological effects of the new radiation available from the cyclotron. Detection equipment used with these isotopes and the techniques of interpretation of results are also discussed. Cyclotron isotope applications included bone and brain tumor localization, blood volume determination, heart muscle blood flow measurement, and thyroid and bone marrow functioning studies. Advantages of isotopes from the cyclotron are considered. (BBB) (TSS)

12879 RADIOISOTOPES IN MEDICINE. I. INTRODUCTORY PHYSICS. de Groot, R. J. (Cancer Inst., Melbourne). Med. J. Austr., 1: 298-300(Feb. 11, 1967).

The following aspects of medical applications of radioisotopes are reviewed: isotopes used in medical treatment, diagnosis, and research, production of isotopes, nature of radioactivity, rates of radioactive decay, radioactive emission, spectra of nuclear radiations, units of radioactivity, measurement of radioactivity, applications, and hazards associated with the use of radioisotopes. In the diagnostic and therapeutic applications of radioisotopes in medicine, accurate measurement of radioactivity is required. The type and degree of sophistication of the radiation detectors and the associated instrumentation to be used will depend on various factors relating to the radioactive source itself and to the type of information required. A discussion is presented on the influence of the following factors on the choice of instrumentation: radioactive properties of the source, physical form, shape, and size of the source, degree of concentration of activity in the source, degree of uniformity of distribution of activity within the source, variation of activity with time, accessibility of the source, and time available for the measurement. (BBB)

12880 ORAL LESIONS PRODUCED IN HAMSTERS BY X RADIATION. Mayo, J.; Carranza, F. A. Jr.; Cabrini, R. L. (Comision Nacional de Energia Atomica, Buenos Aires). J. Oral Ther. Pharmacol., 3: 269-74(1967).

Experiments with total-body and local irradiation were done initially with rats, mice, and hamsters with doses ranging from 400 to 3000 rad. Only the hamsters consistently revealed oral lesions of similar extent, clinical appearance, and evolution to those described in humans. Hamsters whole-body irradiated with 600 rad or less did not develop oral lesions, but all animals irradiated with 900 rad or above had oral lesions. They consisted of yellowish-gray areas in gingival tissue on the lingual aspect of the lower incisors, labial aspect of the upper incisors, and palatal gingiva of the upper molars. With very high doses, the lesions were severe and tended to appear also in other areas of the oral cavity, especially on the tongue. When antibiotics (chlortetracycline and chloramphenicol) were injected intramuscularly daily, irradiation with 800, 1000, and 1500 rad did not produce oral lesions; similar x-ray doses to control animals produced oral lesions in 86, 100, and 100%. Bone marrow transplants reduced the incidence of oral lesions and accelerated healing. β-Mercaptoethylamine (cysteamine) in doses of 150 mg/Kg body weight administered by intraperitoneal injection immediately prior to irradiation reduced oral lesions in 70%; all lesions in protected animals healed but none in the control group. After head irradiation with doses of 1300 and 1400 rad, 30 and 60% of the animals, respectively, devel-

oped tongue lesions consisting of an erythematous and irregular surface. With 3000 rad the lesion was hemorrhagic and was covered by a whitish pseudomembrane. Extraoral lesions consisted of radiodermatitis, sialorrhea, and epilation. Antibiotics had little effect on the development of oral lesions produced by head irradiation, but cysteamine prevented these lesions. (BBB)

12881 THE CLEARANCE OF ^{84}Rb FROM THE HUMAN HEART MUSCLE IN VIVO. Bluemschen, G. (Univ., Freiburg i.B.); Bassenge, E.; Cohen, A. Cardiologia, 50: 33-42(1967).

Rubidium-84 (a positron emitter) and a coincidence-counting-system can be used to measure the human myocardial-flow equivalent. Whether the measurement of disappearance (clearance) of ^{84}Rb by the coincidence-counting-technique could be used to differentiate normal individuals from patients with arteriosclerotic heart disease, as previously found for the washout of ^{131}I, was investigated. Rubidium-84 was constantly infused over a period of 20 min to measure myocardial blood-flow equivalent, then immediately a clearance study was undertaken and a venous sample was drawn. These clearance studies were repeated twice a day. An attempt was made to establish a relation between the decreasing ^{84}Rb activity in the heart muscle and coronary disease by calculating the half-time values of the second part of the clearance curves. With three patients who had coronary heart disease or myocardial infarction and 11 free of coronary-artery-disease, a diagnostic test with respect to the half-time values of the clearance curves could not be established. It was found that the clearance curves consisted of two parts: an early, rapidly declining segment and a slower declining one for the following hours. Rubidium-84 accumulated in the left chest in all patients more than in the right chest, owing to its accumulation in the myocardium. (BBB)

12882 SELENOMETHIONINE-^{75}Se SCANNING. DiGiulio, Walter. J. Amer. Med. Ass., 201: 1053(Sept. 25, 1967).

The site of uptake of selenomethionine-^{75}Se in the chest region, and possible errors in interpretation of scans of this area are discussed. A previous report mentioned vizualization of a thymoma by photoscanning 24 and 48 hr following injection of selenomethionine-^{75}Se. The present author performed such photoscans in 30 patients with proved primary hyperparathyroidism, and noted uptake in the mediastinum. None of these patients had a thymoma, yet the scan was often indistinguishable from the previous authors' scan of a patient with thymoma. It is proposed that the high uptake of ^{75}Se over the mediastinum may be caused by selenomethionine-^{75}Se localized in bone marrow. Since there is a relatively large pool of blood containing ^{75}Se-labeled plasma proteins under this area, the scanner probably detects the blood pool as well. Caution is urged in interpreting selenomethionine-^{75}Se scans of the upper chest area. A thymoma may contribute to the uptake seen over the mediastinum, however, since similar scans can be obtained in patients without mediastinal tumors, these scans cannot reliably predict the presence of either thymic or parathyroid tumors in the mediastinum. The uncertainty of the location of the radioactivity concentration might be avoided by a double-isotope study using an isotope subtraction device. If the blood pool were labeled with the second isotope, most of the background ^{75}Se activity could be erased from the chest scan. Under these circumstances either thymus or intrathoracic parathyroid tumors might be localized by a selenomethionine-^{75}Se photoscan. (BBB)

12883 RADIOISOTOPIC "SUBTRACTION" SCANNING FOR PANCREATIC LESIONS. Eaton, S. Boyd; Potsaid, Majic S.; Lo, Hing Har; Beaulieu, Edward (Massachusetts General Hospital, Boston). Radiology, 89: 1033-9(Dec. 1967).

An isotope subtraction system designed to eliminate liver overlap in pancreatic scanning is described. Gamma radiation from colloidal ^{198}Au in liver and ^{75}Se selenomethionine in liver and pancreas is simultaneously detected by the scintillation detector and processed by dual pulse-height analyzer : ratemeter complexes. The ratio of counts from ^{198}Au and ^{75}Se over the right lobe of the liver is determined, and the apparatus is then operated so that no photoscan image is formed where this ratio is detected. Where pancreatic tissue is present, however, the ^{198}Au : ^{75}Se ratio does not conform to that determined over liver alone, and therefore photoscan image formation proceeds whether or not any liver is anatomically superimposed upon the pancreas. The system speeds and simplifies the scanning procedure and produces scans of superior quality. Interpretation is easier and more reliable. Representative scans of a model system and of clinical cases are presented. It is concluded that isotope subtraction scanning represents a significant advance in pancreatic visualization. (auth)

12884 TRANSPLANTATION OF BONE MARROW. Wei, I-Ch'un. Chung Hua I Hsueh Tsa Chih, 50: 395-8(June 1964).

A comprehensive review of recent studies on bone marrow transplantation is presented. In connection with regenerative disturbances and immunity, the new concept of immunity tolerance, the theory of clone selection, relation between homograft, immunity and thymus, and the phenomenon of radioactive mosaic are summarized. As clinic application, the successful treatment of victims of atomic explosion in a reactor accident, the experiments in treating acute leukemia and aregenerative anemia, and the application in conjunction with drug and radiation therapy of malignant tumors are cited. The methods of bone marrow grafting and ways to determine whether the transplantation is successful are described. (JPRS)

12885 ESTIMATION OF THE ABSOLUTE THYROID UPTAKE OF STABLE ^{127}I USING A SIMPLIFIED METHOD AND COMPARISON OF THE RESULTS WITH TWO CLASSIC METHODS. Akerman, M.; Di Paola, R.; Tubiana, M. (Institut-Gustave-Roussy, Villejuif, France). J. Clin. Endocrinol. Metab., 27: 1309-20(Sept. 1967).

A simplified technique is described for the determination of absolute uptake of stable iodine ^{127}I by the thyroid. The technique was compared with two classic methods in 114 subjects in most of whom the radioactive uptake did not agree with the clinical findings (hyperthyroidism cured by ^{131}I, simple goiter, patients saturated with stable iodine). The technique is based on the existence of a log-log relationship between the early radioactive iodine uptake and the thyroid clearance and on the relative constancy of renal iodine excretion rate constant. The validity of these relationships is discussed with regard to the experimental results obtained. The proposed method only necessitates the measurement of radioactive uptake at 2½ hr and the quantity of stable iodide excreted in the urine between 0 and 2½ hr. The difference between the results obtained using the simplified method and those obtained using the classic methods based on the equality of specific activities is negligible in all groups of patients studied. The diagnostic accuracy of the method is comparable to that of the classic methods. Its simplicity and rapidity allow the absolute uptake of stable iodide to be determined routinely in all patients at the same time as the classic thyroid investigations are carried out. It appears to be particularly useful in evaluating thyroid activity in those patients in whom radioactive uptake does not agree with the clinical state, especially in the follow up of hyperthyroidism treated with ^{131}I and in simple goiters. (auth)

12886 THE INFLUENCE OF THE OXYGEN: NITROGEN SENSITIVITY RATIO ON THEORETICAL DOSE: CURE-RATE RELATIONS. Munro, T. R. (Strangeways Research Lab., Cambridge, Eng.). Brit. J. Radiol., 40: 619-26(Aug. 1967).

Dose: cure-rate curves for single exposures were calculated for model tumors containing various numbers of anoxic cells, and for various values of the oxygen: nitrogen sensitivity ratio m. There is a threshold number of anoxic cells. Numbers much smaller than this have no effect on the dose needed to cure the tumor; with larger numbers all the well oxygenated cells are killed by doses that leave significant numbers of anoxic cells alive. The value of the threshold number depends sharply on m. If the model can be applied qualitatively to the more complex problem of a human tumor, it suggests that when the balance between the success and failure of treatment is determined by the radioresistance of anoxic cells, decreasing m, e.g., by employing radium at a low dose-rate rather than fractionated x radiation at a high dose-rate, should produce appreciably better cure-rates. The clinical data available at present do not support this prediction; possible reasons for the apparent anomaly are suggested. (auth)

12887 POTENTIAL RESOLUTION OF THE SCINTILLATION CAMERA IN THYROID STUDIES. Alexander, Gilbert H. (St. Francis General Hospital, Pittsburgh); Fox, John G.; McAllister, John D. Radiology, 89: 898-902(Nov. 1967).

Considerable improvement is possible in the resolution of photographs taken with a γ scintillation camera and pin-hole aperture. A standard camera was modified so as to increase the distance from crystal to pin-hole until the image fills the crystal. The increase in exposure required for the larger image on the crystal can be cancelled by electronically minifying the oscilloscope image without loss of detail in the final picture. The competing effects of effective pin-hole size and electronic resolution result in the same final resolution for ^{131}I and ^{99m}Tc. (auth)

12888 A CLINICAL PHARMACOLOGIC STUDY OF CHEMOTHERAPY AND X-RAY THERAPY IN LUNG CANCER. Hall, Thomas C. (Pondville Hospital, Walpole, Mass.); Dederick, Margarida M.; Chalmers, Thomas C.; (and others). Amer. J. Med., 43: 186-93(Aug. 1967).

The possible synergistic effect of two chemotherapeutic agents on x-ray treatment of lung cancer was tested in 342 patients at eight different treatment centers. Actinomycin D or 5-fluorouracil was given with x rays in a dose regimen sufficient to produce definite but tolerable gastrointestinal and bone marrow toxicity.

Radiation therapy was given as supervoltage or orthovoltage with a total tissue dose of 5000 R given within five weeks as equal fractions over a 5-day week. Neither combination increased the percentage of patients with carcinoma of the lung showing shrinkage of lesions in the irradiated field. There was no evidence of a more rapid onset of shrinkage of the tumor or of an additive effect at subtotal doses of x rays. Patient survival was not affected beneficially by the addition of the chemotherapeutic agents. Toxicity was not correlated with responses induced. Evaluation of side effects indicated that addition of drugs to x-ray therapy increased the incidence of gastrointestinal toxicity and marrow suppression. Actinomycin D induced slightly more toxicity than did 5-fluorouracil. Dermatitis did not appear in previously irradiated areas in patients receiving actinomycin D. (BBB)

12889 HYPERBARIC OXYGEN AND RADIOBIOLOGY OF A C3H MOUSE MAMMARY CARCINOMA. Suit, Herman D.; Maeda, Morimasa (Univ. of Texas, Houston). J. Nat. Cancer Inst., 39: 639-52(Oct. 1967).

A series of radiation dose-tumor control response assays was performed on the first-to-fourth generation isotransplants of a C3H/J mouse mammary carcinoma for radiation administered under four different conditions: hypoxia, a clamp across the root of the tumor-bearing part for 1 minute before treatment, air, animal respiring air at one atmosphere of pressure; O_2 30 or 44 psi, animal respiring pure oxygen at 30 or 44 psi for 15 minutes before and during local tumor irradiation. When radiation was administered as a single dose ($\nu = 1$) to 250 mm^3 tumors, high pressure oxygen was only modestly effective in reducing the tumor control dose (TCD50), TCD50 hypoxia/O_2 30 psi and TCD50 hypoxia/O_2 44 psi were only 1.2 and 1.3, respectively. However, for similar treatment of 0.6 mm^3 tumors and of even smaller microcolonies, the ratios TCD50 hypoxia/O_2 44 psi were 2.5 and 3.2, respectively. These results are discussed with respect to simple tumor models so as to estimate the proportion of hypoxic cells present in tumors under normal conditions and the influence of oxygen breathed at increased pressure on that proportion. High pressure oxygen was found much more effective when combined with fractionated irradiation ($\nu = 10$) than with single-dose therapy. Thus TCD50 hypoxia/O_2 30 psi was 2.2 ($\nu = 10$) instead of 1.2 ($\nu = 1$). Finally, the ratio TCD50 hypoxia $\nu = 10/\nu = 1$ was 2.15. These results are reviewed and inferences drawn as to the extent of tumor cell proliferation between treatments, repair of sublethal radiation injury by hypoxic cells, and the movement of cells from the hypoxic compartment to the aerobic compartment during fractionated irradiation ($\nu = 10$) under normal conditions. (auth)

12890 A NEW TYPE OF RADIOACTIVE WIRE SOURCE. Sakhatshiev, Andrey A.; Moushmov, Marino D. (Oncological Research Inst., Sofia-Darvenitza, Bulgaria). Radiology, 89: 903-5(Nov. 1967).

A new type of radioactive linear source, for use for interstitial γ radiotherapy, made by radioactive wire (most commonly ^{182}Ta or ^{192}Ir) introduced into the tract of a round surgical thread and fixed in resin, is reported. This source possesses all the advantages of the radioactive wire and at the same time permits double overloading at one or both ends. Implantation is performed by means of an afterloading technic, the nonradioactive end of the thread being guided with the help of a surgical needle or with a specially designed needle-stylet. (auth)

12891 RADIOLOGICAL PHYSICS OF PION. Baarli, Johan (CERN, Geneva). Radiat. Res., Suppl. 7, 10-19(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

The possible applications and problems associated with negative pion beams for therapy, radiobiology, and dosimetry are reviewed. Some experiments are described of the dose distribution in water irradiated with a 70-MeV pion beam from the CERN 600-MeV Synchro-Cyclotron. The results show that the maximum dose rate is measured at 14.8 cm penetration depth with a 2.2 ratio between this and the entrance dose rate. Isodose distribution of this beam in water is also presented. The quality factors (QF) evaluated from measurements with a high-pressure tissue-equivalent ionization chamber show values from 2.7 to 3.4 in the peak and a value of one at the beam entrance. Calculated depth doses compared with the measurements seem to indicate that about 20 MeV is locally deposited in water per interacting negative pion. Considering QF and buildup factors, particles per cm^2 per sec for producing 1 mRem per hr are compared with 400-MeV neutrons, 600-MeV protons, and 70-MeV pions. (auth)

12892 RADIOBIOLOGICAL STUDIES WITH HEAVY PARTICLES AS RELATED TO THERAPY. Lawrence, John H. (Univ. of California, Berkeley). Radiat. Res., Suppl. 7, 360-8(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Mammalian radiobiological studies of the interesting effects of heavy particles have been greatly extended since 1935 when investigations with cyclotron-produced fast neutrons showed that the very dense ionization produced by heavy ions (secondary protons) had a greater biological effect on both normal and neoplastic cells than that of x rays or γ rays. In addition to the greater relative biological effect, heavy particles have other therapeutically advantageous characteristics including less scatter, greater penetration, independence of oxygen concentration, lack of tissue recovery, and Bragg-peak effect. Since 1954 high-energy heavy-particle beams have been used to deliver large amounts of energy to relatively localized areas of the body, including the pituitary gland, brain, and soft tissues, in the successful treatment of several metabolic, neoplastic, and neurologic diseases. Information concerning heavy-particle irradiation of man, although limited today to data on specific areas of the body, is helping us toward a better understanding of the hazards of space radiations, especially solar flares of heavy particles. 48 references. (auth)

12893 RADIOLOGICAL PROPERTIES OF BEAMS OF HIGH-ENERGY PROTONS. Larsson, Borje (Univ. of Uppsala). Radiat. Res., Suppl. 7, 304-11(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

A review of the experimental data showed that protons in the energy interval from 20 MeV and up to a few hundred MeV of energy have about the same quantitative and qualitative effects on tissues as other sparsely ionizing radiation, except for a narrow zone in the final part of their range in which there was a marked increase in RBE. (auth)

12894 RADIATION ACCIDENTS AND THEIR MANAGEMENT. Andrews, Gould A. (Oak Ridge Inst. of Nuclear Studies, Tenn.). Radiat. Res., Suppl. 7, 390-7(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Radiation accidents are valuable sources of information on radiation effects in man since, unlike therapeutic radiation, they usually involve normal people; however, accurate dosimetry is often lacking. Hematologic changes were found to be both the most serious clinical effects and the best biological index of dose. Curves are presented which show typical hematologic responses of the adult human to 200, 300, and 450 rads of acute whole-body radiation. Continuous accidental exposure to radiation for weeks resulted in a different pattern of radiation effects and recovery than did acute exposure. The application of data obtained from accidents to radiation hazards in space is discussed. In contrast to the results of others, it was found that 50 to 100 R whole-body irradiation given to patients with chronic blood diseases did not significantly enhance sensitivity to a second dose serveral months later. The need for more data on radiation effects in man is stressed. (M.M.B.)

Radiation Effects on Animals

Refer also to abstracts 12744, 12745, 12750, 12752–12759, 12763–12765, 12783, 12784, 12786, 12790, 12796, 12797, 12803, 12805, 12807–12812, 12825, 12833, 12837, 12839, 12840, 12846, 12851, 12853, 12858, 12865, 12868, 12874, 12875, 12880, 12889, 12892–12894, and 12949.

12895 (AED-C-16-03-I) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. ZWISCHENFAELLE BEIM UMGANG MIT IONISIERENDEN STRAHLEN. (Bibliographies in Nuclear Science and Technology. Handling of Radioisotopes, Accidents). Marcinowski, H.-J. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Aug. 1967. 422p. (In German). Dep.

One-thousand eight hundred and fifty-five incidents of accidental exposure of man to ionizing radiation during handling of isotopes or radiation sources are compiled chronologically, beginning with the burning of the skin of an engineer with x rays in 1896. Bibliography data on the incidents were compiled from books, conferences, dissertations, reports, and journals. (J.S.R.)

12896 (STI/PUB-21/24) RADIOISOTOPES AND IONIZING RADIATIONS IN ENTOMOLOGY. VOL. III. (1964–1965). Bibliographical Series No. 24. (International Atomic Energy Agency, Vienna (Austria)). 1967. 454p. IAEA: $9.50; Austrian Schillings 246,-; Pound 3.7.0; F Fr 46,70; DM 38,-.

More than a thousand references to the literature for the two-year period 1964–1965 are presented. The first two volumes, Bibliographical Series Nos. 9 and 15, cover the eleven- and three-year periods 1950–1960 and 1961–1963, respectively. The bibliography is fully annotated and abstracts are included whenever possible. Tables give a systematic list of insects and related

arthropods, sterilization data, lethal radiation effects, and radioisotope tracer studies on insecticides. An author index, a detailed subject index, and an insecticide index are provided. (auth)

12897 (SZS-12/67) SCHAEDEN AN RATTENFOETEN NACH GANZKOERPERBESTRAHLUNGEN MIT 400-1000 R. (Damage to Rat Fetuses by Whole-Body X Irradiation with 400 to 1000 R). Goetze, E.; Haude, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Aug. 1967. 46p. (In German). Dep.

Rat fetuses were more sensitive than dams to whole-body x radiation in doses of 400 to 1000 R. The effects of dose on birth weight, prenatal, and postnatal death rates were evident. Recovery from the effects of radiation was also observed, especially in the hematopoietic system. Histological studies revealed a high degree of fat accumulation in the fetal liver and placenta. Studies utilizing carbon-14-labeled glycine showed that protein synthesis in the fetal liver was impaired by radiation and that the degree of damage was proportional to the radiation dose. Radiation caused a premature production of transaminases, uricase, and isozymes of amylase. Endocrine functions, placental transport mechanisms, and other metabolic processes were impaired by radiation. Radioinduced chromosome aberrations in the bone marrow of young rats were also studied. (tr-auth)

12898 (N-67-29205) SPACE BIOLOGY AND MEDICINE. Translation of Kosm. Biol. Med., 1: No. 1, 4-92(1967). 120p. (NASA-TT-F-11100). CFSTI.

Separate abstracts were prepared for two papers. Thirteen additional papers are included on various aspects of problems encountered in space biology and medicine. (H.L.W.)

For abstracts of individual papers see: 12899 and 12939.

12899 (N-67-29205, pp 77-82) RADIATION SAFETY OF MANNED SPACE FLIGHTS (RADIOBIOLOGICAL ASPECTS). Grigoriev, Yu. G.; Kovalev, E. E. Translated from Kosm. Biol. Med., 1: No. 1, 64-8(1967).

Safety criteria with regard to crew irradiation on short and long term space flights are considered. The recovery process after repeated exposures to radiation, determination of the degree of radiation damage during flight, and development of methods of preliminary estimation of the astronaut's radiosensitivity are evaluated. Radiosensitivity of plants used as food for astronauts is estimated; data on effects of 126 to 660 MeV protons on higher plants are presented. (H.L.W.)

12900 RADIOACTIVE IODINE, ANTITHYROID DRUGS, AND SURGERY IN TREATMENT OF HYPERTHYROIDISM. Plested III, William G.; Pollock, William F. (Univ. of California, Los Angeles). Arch. Surg., 94: 517-23(Apr. 1967).

The risk of carcinogenesis and hypothyroidism from ^{131}I treatment of hyperthyroidism is considered. There is increased incidence of benign and malignant thyroid tumors in individuals subjected to irradiation of the thymic area in infancy. Most of the reported thyroid tumors have appeared in children after external radiation, but there are reports of the same phenomena after internal irradiation with ^{131}I. Because of the fear of carcinogenesis, most treatment centers arbitrarily restrict the use of radioiodine therapy to adults over the age of 40, but some centers have lowered this limit to 24 yr. Most centers will not treat pregnant women or nursing mothers, since the isotope can cross the placenta and will enter the milk of the nursing mother. Thyrotoxic patients as young as three yr of age were treated with radioiodine. All reports of thyroid tumors appearing after ^{131}I therapy came from the institutions that used this treatment for hyperthyroidism in children. In addition to the benign nodules, two cancers of the thyroid were reported in children after this therapy, but none in adults. Evidently the rapidly growing thyroid tissue of children is more sensitive to ionizing radiation than adult tissues. There were 27 cases of leukemia reported in ^{131}I-treated patients, but whether this incidence is higher than control levels is not known. The most frequent and serious complication of radioiodine therapy is the unexpectedly high and rising rate of hypothyroidism. The present trend in ^{131}I therapy is to give repeated doses until clinical remission is achieved. (BBB)

12901 PHENOMENOLOGY OF RADIATION EFFECTS ON ORGANS AND ORGAN SYSTEMS. II. MORPHOLOGIC CHANGES IN BLOOD CELLS (PERIPHERAL BLOOD). Moraczek, Adolf (Medizinischen Akademie, Magdeburg, Ger.). pp 273-302 of Handbuch der Medizinischen Radiologie, Vol. 2, Part 2. Berlin, Springer Verlag, 1966. (In German).

The historical development of studies of radioinduced morphological changes induced in blood cells is reviewed. This is followed by a discussion of radioinduced changes in blood cells caused by whole-body irradiation in animals, by localized irradiation, and by in vitro irradiation. The sequences of changes in the blood cell picture and the over-all nature of morphological changes in blood cells caused by irradiation are discussed. The significance of morphological changes of blood cells is examined. References cited, 147. (BBB)

12902 IRRADIATION ULCER OF THE URINARY BLADDER. Masterson, Byron J. (Kansas Univ., Kansas City); Rutledge, Felix. Obstet. Gynecol., 30: 23-7(July 1967).

Development of urinary tract complications associated with radiotherapy of carcinoma of the cervix was evaluated. In 1167 patients studied, 13 radiation ulcers were noted, an incidence of 1.1%. A detailed report is given of these 13 patients plus four additional irradiation ulcer patients that were observed. There was no correlation between ulcer occurrence and bladder dosage. The time interval from the beginning of radiotherapy to the onset of urinary symptoms leading to the diagnosis of radiation ulcer varied throughout from two to 21 months with an average of 8.9 months. The nature of the symptoms seemed related to the time of onset of the ulcer. With conservative management, the radiation ulcers were healed in less than 36 months. (BBB)(TSS)

12903 CLONAL REPOPULATION IN RETICULAR TISSUES OF X-IRRADIATED MICE: EFFECT OF DOSE AND OF LIMB-SHIELDING. Nowell, Peter C.; Cole, Leonard J. (Univ. of Pennsylvania, Philadelphia. Naval Radiological Defense Lab., San Francisco). J. Cell. Physiol., 70: 37-44(Aug. 1967).

Chromosome studies in irradiated mice have indicated that following high sublethal whole-body exposure regeneration of the reticular tissues occurs in a clonal fashion. With increasing doses, from 100 to 700 rads, these organs appeared to be repopulated from fewer and fewer surviving stem cells. In a few instances at the highest dose, the progeny of the same cell apparently differentiated to marrow cells at one site and to lymphoid cells in others, suggestive evidence of a totipotent hematopoietic stem cell in the adult mouse. Chromosome studies in mice receiving 900 rads with one limb shielded have indicated repopulation of the thymus and other reticular tissues by undamaged cells from the shielded marrow. Such marrow-derived cells, perhaps by restoring immunological competence or by non-immunological contact inhibition, could account for the known effect of limb shielding in reducing the incidence of radiation-induced thymic lymphomas. (auth)

12904 RADIOINDUCED CONTRACTION OF SKELETAL MUSCLES IN FROGS. Saneblidze, O. I. (Inst. of Physiology, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 47: 457-62 (Aug. 1967). (In Russian).

In processes of irradiation of isolated skeletal muscles of frogs at doses output of 20 to 50 krad/min, spontaneous contraction of the muscle occurs. In some cases the contraction developed in minutes at doses from 159 to 180 krad (fast form) and in others the contractions developed slowly in the course of 20 to 30 min at doses of 200 to 300 krad (slow form of radioinduced contraction). Stretching of the muscle after development of the fast contraction reduces the effect of the contraction, whereas in the slow contractions independently of the protraction or ceasing of the radiation a return to the contracted state occurs. The stopping of the irradiation causes stopping of a growth of the contractions and the formation of a sharp plateau in the fast form whereas the slow contraction continues to be intensified. (tr-auth)

12905 LOCAL IONIZING RADIATION EFFECTS ON THE HEART ACTIVITY IN FROGS. Nadareishvili, K. Sh.; Gugushvili, B. S.; Kakhiani, E. D. (Inst. of Physiology, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 47: 451-6(Aug. 1967). (In Russian).

The local effect of x radiation on the frog heart at dose output of 10 krad/min and total dose of seven to 30 krad produce an effect similar to positive inotropic and a negative tonotropic effect as well as an insignificant increase of the EG voltage. At total dose of 80 to 100 krad, a decrease of the EG voltage and a decrease of force of the contraction of the positive tonotropic effect background were observed. At dose output of 40 to 50 krad/min increases of the mechanical response were not observed, but at the same time some increase of the EG amplitude takes place. With increase of the total dose the degree of diastolic weakening was decreased and stopping of the heart set in with symptoms similar to the development of contractures in skeletal muscles. (tr-auth)

12906 EARLY-STAGE CYTOLOGICAL CHANGES IN SMALL INTESTINE MUCOSAE OF MICE DAMAGED BY X RADIATION. Chai, Chung-ho; Lo, Yu-lien; Shen, T'ung. Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh, 10: 89-101(1964). (In Chinese).

In the first of three experiments, mice received a lethal dose of 720 R of x rays at the rate of 100 R/min. Body weight, food intake, digestive function, and urinary excretion of amino acids were ob-

served after 3, 6 and 12 hr. Cytological and histochemical changes in the mucosae of small intestine, thymus glands, adrenal glands, bone marrow, testes, liver, and pituitary body were also analyzed. Death within 30 days after irradiation was caused by digestive tract damage. In the second experiment, two groups of four month old mice received an x ray dosage of 720 R given at 100 R/min. Internal organs were removed and fixed after 24 hr. Cytological, histological, and histochemical changes in the mucosae of small intestine, and various glands were analyzed. In the third experiment, mice received 720 R of x rays. Early-stage changes of cell structure and histochemical reaction of nucleic acid in the cells of the intestinal recess after 3, 6, 12, and 24 hr were observed. Observation results follow: Experiment one showed a 40% decrease in food intake, a 6% body weight loss, the digestive function of the small intestine was weakened, and amino acids were detected in the urine. Experiment two showed swollen blood vessels in the mucosae filled with red cells, the intestinal recess was damaged, cell division in the germ epithelium ceased, the thymus glands, adrenal glands, and testes were also damaged. Experiment three showed a disorderly arrangement of epithelial cells in the intestinal recess with a reduction in cell number twice that in the control group, structure and histochemical reaction of nucleic acid were found to change due to breakdown of the high molecular form of DNA, and chromosomes lost their original characteristics and became clumpy and were surrounded by a substance believed to be RNA of unknown origin. It is also believed that changes taking place in the intestinal recess might affect the secretional functions of Paneth's cells. (JPRS)

12907 EFFECT OF SMALL CONCENTRATIONS OF URANIUM IN WATER ON THE POPULATION'S HEALTH. Novikov, Yu. V. (Scientific-Research Inst. of Hygiene and Sanitation, Moscow). Gig. Sanit., No. 10, 33-40(Oct. 1967). (In Russian).

A study of the effect produced by small concentrations of uranium on the population's health proved the demographic indices of settlements A and B (birth, mortality, natural increase of population) to be almost the same. Certain deviations could not be traced to the action of small concentrations of uranium. Neither could it be the cause of child mortality. The sex ratio in town A did not differ from that prevailing in the USSR, in the town B it was more favorable, attaining the optimum for the population's increase. In the towns A and B persons within the age of 19 made up 42 per cent of the population. The main part of the population in these towns (81.2 and 72.3%) was indigenous. The causes of mortality due to malignant growths and the main classes of diseases and the morbidity rate of malignant growths among the population of towns A and B presented no significant difference. A study of the physical development of newborn children revealed no significant difference in the weight of boys and girls in towns A and B. However, the height of boys and girls at the town B was somewhat greater than in town A. (auth)

12908 ACUTE INJURIES CAUSED BY NEUTRON IRRADIATION: ITS EFFECTS ON THE INTESTINAL TRACT AND HEMATOPOIETIC ORGANS. Hirose, Fumio (Hiroshima Univ.). Acta Pathol. Jap., 16: 361-410(Nov. 1966).

Mice of the ddN and ICR strains and Wistar rats were given a single whole-body dose of 320 to 800 rad of 14.1 MeV neutrons or divided doses of 600 rad each. The results were compared to those obtained with 180-KV x rays and ^{60}Co γ rays. Bone marrow damage in mice and rats following neutron irradiation was greater than that following x and γ rays of equivalent absorbed dose and of doses with equivalent effects on acute death, but was slightly greater than that owing to x- and γ-ray doses considered to have equivalent effects on decrease in nucleated bone marrow cells. On the contrary, damage to lymphatic tissue and intestinal mucosa of mice and rats following neutron irradiation was invariably greater than that following x and γ rays. The mucosal membrane of the small intestine of neutron-irradiated animals showed pronounced mitotic inhibition and severe chromosomal damage. Ulcers observed early in the duodenal mucosa, prior to the denudation of the villi, became the source of generalized infection and probably promoted acute death at the time of villus denudation or earlier. The frequency of bone marrow deaths was low in neutron-irradiated animals and high x- and γ-irradiated animals, perhaps because the recovery of hematopoietic tissue and intestinal mucosa at two to three weeks following neutron irradiation was comparatively smooth, but delayed following x and γ irradiation after which injuries appeared in the intestinal mucosa. The decrease in mortality rate after equally divided exposure to a lethal dose was marked in neutron-irradiated mice and slight in γ-irradiated mice, perhaps because intestinal deaths in neutron-irradiated animals were markedly reduced as a result of decreased damage to the intestinal mucosa and bone marrow. (BBB) (TSS)

12909 MELANIN GRANULE MODELS FOR PULSED LASER INDUCED RETINAL INJURY. Hansen, W. P.; Fine, S. (Northeastern Univ., Boston). Appl. Opt., 7: 155-9(Jan. 1968).

Two models for retinal threshold injury on exposure to intense light (laser) pulses ranging from 0.1 sec to 10^{-8} sec, are discussed. In both models, the melanin granules in the retina are considered as the primary absorption site—the site of greatest energy absorption per unit volume in the retina. The single mechanism granule model considers that a specific temperature must be reached in the perigranular region to produce injury. The two-mechanism model assumes that production of steam is not required for injury at long pulse durations—that is, injury at long pulse durations is essentially thermal—but that once steam is produced, injury is related to steam production. The models agree with experimental observations that indicate that the energy for threshold injury decreases as the pulse duration is shortened to the Q-switched range. (auth)

12910 POSTIRRADIATION COSTAL OSTEOCHONDRITIS SIMULATING METASTATIC CANCER. Lau, B. Peck (Univ. of Texas, Houston). Radiology, 89: 1090-2(Dec. 1967).

Three cases are presented of postirradiation osteochondritis of the costochondral joints after high-dose and few-fractions radiotherapy. Some clinical features are described that are considered important in differentiating this lesion from metastatic or recurrent cancer. The radiotherapist should be alerted when painful, discolored, stony induration develops in a previously heavily irradiated port over the sternum, and the surgeon should refrain from tampering with the lesion. Tetracycline is recommended as the treatment for this condition. (auth)

12911 COMPARISON OF THE LETHAL EFFECT OF RADIATION ON MICE FOR ACUTE AND PROTRACTED RADIATION. Joslin, C. A. F.; Ramsey, N. W.; Andrews, H. J. (Charing Cross Hospital, London). Brit. J. Radiol., 40: 627-30(Aug. 1967).

The doses of γ rays producing 50 per cent lethal effect in four days, and in 30 days, were measured for mice, irradiated in 15 minutes or 24 hours. The results confirm the sparing effect of the lower dose rate, and suggest that this effect may vary with different types of tissue. (auth)

12912 EFFECTS OF ^{137}Cs AND ^{90}Sr ON THE GROWTH AND REPRODUCTION OF MICE. IV. Nishio, Kazuo; Megumi, Tsuneo. Annu. Rep. Radiat. Center Osaka Prefect., 7: 104-6 (1966).

Effects of ^{90}Sr and ^{137}Cs were studied in respect to abnormalities of reproduction and life-span in mice administered these isotopes till the 8th generation. The group of mice fed with water contaminated with 0.04 μc of ^{137}Cs and 0.01 μc of ^{90}Sr per ml showed shortening of average life-span since the 5th after prolonging the 2nd, 3rd, and 4th generations in their life-span as well as increase of number of litters in first birth. In the group of mice administered with 0.004 μc of ^{137}Cs and 0.001 μc of ^{90}Sr per ml, increase of these two indexes was observed throughout seven generations except the 1st. Survivors for more than 130 days of these mice irradiated with 700 R of x ray were more in the latter group than in the control group, while none were in the former group, among young animals in generations from 5 to 15. (auth)

12913 EFFECTS OF GAMMA IRRADIATION WITH ^{60}Co ON ERYTHROCYTES OF FEMALE FISCHER RATS. Ring, Gordon C. (Univ. of Miami, Fla.); Dauer, Maxwell; Johnson, Beatrice; James, George. J. Gerontol., 22: 456-8(Oct. 1967).

Whether radiation brings about changes in rat bone marrow cells which result in an early modification of the erythrocytes formed, so that they are similar to those found in aging rat, was studied. Differences in the responses to irradiation in adult rats of different ages were also examined. The rats were irradiated with ^{60}Co and given penicillin for one month thereafter to reduce the danger of infection. After a single whole-body dose of 400 rad, the changes in the erythrocytes were too small to measure. After two repetitions of this dose at monthly intervals with no measurable effect on erythrocytes, a single larger dose of 1100 rad brought about death within 30 days. Therefore, for a study of chronic effects of exposure the dose was reduced to 1000 rad. Irradiation of young adult rats (200 to 300 days of age) with 1000 rad produced a rapid decrease in erythrocytes, hemoglobin, and hematocrit. A return of the normal numbers of erythrocytes in the peripheral circulation occurred in about 40 days. Anemia developed at 500 to 600 days of age in these rats, earlier than this condition was found in nonirradiated rats (700 days). (BBB)

12914 AN ANALYSIS OF THE COMPLICATIONS OF THE RADIOLOGIC TREATMENT OF CARCINOMA OF THE CERVIX. Calame, Richard J.; Wallach, Robert C. (State Univ. of New

York, Brooklyn). Surg. Gynecol. Obstet., 125: 39-44(July 1967).

Radioinduced complications in a series of 718 patients with invasive cervical cancer irradiated between 1951 and 1964 are reported. Three distinct regimens of radiation therapy were in effect in this period. From 1951 to 1956, conventional (250-KV) x rays in doses of 3000 R were given to the tumor through four ports in 10 to 12 weeks. Radium in intracavitary and contracervical doses of 6000 to 7500 mg-hr was administered before, during, or after external therapy. From 1956 to 1962, external therapy was administered by the same apparatus, achieving a full tumor dose in a shorter period (four weeks). In 1962 the present regimen consisting of large field, whole pelvis, rotational ^{60}Co therapy was introduced. Following exposure to radiation, an inflammatory reaction resulted with congestion, exudation, necrosis, and finally, repair of the tissues. Radiation injuries fell into two general categories, early and late. The early injuries were usually relatively mild and transient. The late injuries were the end products of progressive endarteritis, the urinary tract injuries usually appearing later than the rectal. In the first period full radiation therapy was administered to 137 patients. Of this number, 37 patients developed severe complications; three of these died. Of the 169 patients of the second period who received full therapy, 17 developed severe complications; three of these died. Of fifty patients who completed the course of ^{60}Co therapy, seven developed severe complications; only one of these died. Thus, those treated between 1951 and 1956 had a higher incidence of more severe complications. Eleven intestinal and urinary tract fistulas occurred in the 1951 to 1956 group and only one such fistula in the patients treated between 1956 and 1962. The patients in the earlier series received higher doses of Ra and, very likely, this played a role. The rate of complications in stage II was twice that in stage III cervical cancer, perhaps explained by the fact that the latter patients did not survive long enough for complications to appear. (BBB)

12915 RENAL ADENOCARCINOMA: POSTOPERATIVE RADIATION THERAPY. Arner, O.; Edsmyr, F.; von Schreeb, T.; Sundbom, L. (Karolinska Sjukhuset, Stockholm). Acta Chir. Scand., 132: 377-83(Oct. 1966).

Effects of postoperative x and γ irradiation in 20 cases of renal adenocarcinoma (hypernephroma) are reported, with emphasis on prevention of radioinduced renal injury by an improved method. The treatment consisted in 14 cases of 200-KV x irradiation and in 6 cases of ^{60}Co γ irradiation. Two opposed fields were used in some cases, but in most instances the three-field technique was employed. Examples of the dose distribution obtained in the horizontal plane at the level of the second lumbar vertebra with the latter technique are shown. In the improved radiation technique with ^{60}Co described, insertion of wedge filters permitted the planned dose throughout the area to be treated to be kept within $\pm 5\%$, in contrast with the earlier inhomogenous dose distributions. The aim was to give all patients a tumor dose of 5000 rad within five to six weeks, but the dose used was appreciably lower. This was especially true in the medially situated portion of the volume to be treated. Here, on the average only about 2000 rad was obtained with 200-KV x radiation, and around 3000 rad with ^{60}Co γ radiation. A disadvantage of the new technique was that the sound kidney received 500 to 2000 rad, a higher dose than that associated with the older techniques. Doses as low as 1000 to 2000 rad may cause acute or chronic lesions (nephritis) that may be fatal. The possibility of damage to the medulla must also be considered. More accurate individual dose planning, improved radiation geometry, and more rigid control of the position of the radiation beams may reduce the dose in boht the medulla and the sound kidney. (BBB)

12916 URINARY EXCRETION OF DEOXYCYTIDINE IN RATS AFTER X IRRADIATION: DOSE-RESPONSE AND EFFECT OF AGE. Guri, Charles D.; Swingle, Karl F.; Cole, Leonard J. (Naval Radiological Defense Lab., San Francisco). Int. J. Radiat. Biol., 12: 355-65(1967).

Rats were exposed to various doses of whole-body x-rays, from 10 R to 400 R, and 24-hour urinary deoxycytidine (CdR) excretion was determined by combined ion exchange and paper chromatographic methods. The baseline 24-hour urinary CdR excretion (non-irradiated rats) was 86.6 ± 13.9 μg; while after exposure to 28 R and 223 R, a significant increase of 70 per cent and 260 per cent, respectively, was observed. The highest rate of CdR excretion occurred during the first 24 hours after irradiation, and returned to baseline levels by the second day. A linear dose-response relationship was found for 24-hour CdR excretion at radiation doses over the range of 10 R to 223 R. For a given radiation dose, CdR excretion was considerably lower in rats previously splenectomized; thus, at 100 R the spleen appeared to contribute 82 per cent of the excreted CdR. Age of the rats was an important determinant of CdR excretion: after exposure to 100 R, 5-week-old rats showed a 312 per cent increase in 24-hour urniary CdR content over that of non-irradiated age controls; for 12-week-old animals the increase was 123 per cent; in 14-month-old rats, the increment was only 47 per cent. The biochemical origin of the excreted CdR as a degradation product derived from the polydeoxyribonucleotides, previously shown to be released in spleen and thymus at early times after irradiation, was suggested. It was concluded that urinary CdR excretion could be potentially useful as a biochemical index of radiation exposure. (auth)

12917 THE INCREASE IN LIVER GLYCOGEN IN NON-FASTED RATS AFTER IRRADIATION. A COMPARISON WITH PAIR-FED ANIMALS. Hansen, Lis (Finsen Lab., Copenhagen). Int. J. Radiat. Biol., 12: 367-72(1967).

It was shown that the level of liver glycogen was higher in the irradiated rat (450 R) than in the pair-fed rat for the first 6 days after irradiation. Compared with the normal rat the level of liver glycogen was low after the first day, the same on the fourth day and higher on the sixth day after irradiation. Body-weight, food consumption, weight and nitrogen content of the liver were measured. (auth)

12918 MODEL FOR CUMULATIVE DAMAGE IN SYSTEMATIC γ-IRRADIATION OF CONSTANT INTENSITY. Malakhovskii, V. N.; Oreshkin, I. G.; Laptev, A. I.; Khoruzhenke, A. F.; Golubkov, A. I.; Rezon, V. A. Radiobiologiya, 7: 357-60(1967). (In Russian).

In the model for cumulative damage in systematic γ irradiation that is proposed, the irreversible action of radiation (i.e., death of individual animals) was regarded as a development of changes incompatible with life that developed in the body following irradiation. In the expression derived, the index for intensity of recovery during chronic irradiation was related in a complex manner to the magnitude of the daily radiation dose. An estimation of this index on the basis of data obtained in experiments on the irradiation of rats indicated that the recovery reached an upper limit at a daily dose close to 100 R. Extrapolation showed that an upper limit for systematic exposure to γ-radiation existed at which the life span was not shortened by development of radiation sickness. For rats this limit corresponded to a daily radiation dose of the order of 1 R. (JPRS)

12919 INTERACTION EFFECTS OF ENVIRONMENTAL STRESS AND DEUTERON IRRADIATION OF THE BRAIN ON MORTALITY AND LONGEVITY OF C57BL/10 MICE. Ordy, J. M.; Samorajski, T.; Zeman, W.; Curtis, H. J. (Cleveland Psychiatric Inst, Indiana Univ., Indianopolis, Brookhaven National Lab., Upton, N. Y.). Proc. Soc. Exp. Biol. Med., 126: 184-90(Oct. 1967).

Observations were made on differences in mortality and longevity among four experimental subgroups of six successive cross-sectional age samples of non-irradiated and brain-irradiated C57BL/10 mice during their entire life span. The four subgroups of each main cross-sectional age sample included: steady-state controls, temperature stress, electric shock stress, and combined temperature and electric shock stress. Irradiation of the brain was performed with a 20 MeV deuteron beam delivered at a dose rate of 383 rad/sec through an anti-Bragg wheel by the 60 inch Brookhaven cyclotron. The mice received a dose of 500 rads over the dorsal surface of the brain covering an area of 9 × 5 mm to a depth of 2.5 mm. All irradiated mice were then assigned to four cross-sectional groups and exposed to the same four experimental stress treatments in the two environmental chambers in accordance with the experimental design. There was a highly significant decrease in the longevity of the brain irradiated mice. Contrary to expectation, stress resulted in a significant decrease in mortality and a longer life span of both the non-irradiated and brain-irradiated mice. The significant difference in mortality and longevity between males and females observed in the non-irradiated mice was not found in the brain irradiated mice. The significantly lower mortality and longer life span of stressed mice whose life expectancy had been reduced significantly by brain irradiation provided compelling evidence against some current stress theories of biological aging. In summary, environmental stress did not accelerate the aging of non-irradiated or brain-irradiated mice. From the non-additive interaction effects of environmental stress and deuteron irradiation of the brain on mortality and longevity of C57BL/10 mice, it was concluded that stress induced decreases in mortality and a longer life span were consistent with evolutionary theories of natural selection and survival of multicellular populations under fluctuating environmental conditions. (auth)

12920 ANGIOGRAPHIC EVALUATION OF THE EFFECT OF TRAUMA AND IRRADIATION ON TRANSPLANTED LYMPHOSARCOMA IN MICE. Noonan, Charles D.; Margulis, Alexander R.; Patt, Harvey M.; Stoughton, James (Univ. of California, San Franicsco). Radiology, 89: 923-8(Nov. 1967).

The effects of localized trauma and of x irradiation on the vascularization and growth of a transplanted lymphosarcoma in mice were studied by means of angiography. Fracture immediately before tumor transplantation appeared to promote vascularity and tumor growth and to accelerate death of the host. The effect of trauma depended somewhat upon the size of the tumor inoculum, being more pronounced with the smaller inocula. Prior irradiation of the tumor site modified the vascular and tumor growth patterns but did not affect survival. The effect of fracture on tumor growth and survival was a local, rather than a systemic, phenomenon. This conclusion is indicated by a lack of effect of a contralateral fracture. For reasons unknown, survival was decreased when a contralateral fracture was induced in a mouse in which the site for transplant had been irradiated previously. (auth)

12921 SPACE RADIATION BIOLOGY. Proceedings of a Workshop Conference Held at the University of California, Berkeley, September 7–10, 1965. Schambra, Philip E.; Stapleton, George E.; Barr, Nathaniel F. (eds.). Radiat. Res., Suppl. 7, 1-470(1967). CONF-650924–(Suppl.).

Separate abstracts were prepared for the 38 papers presented at the conference. Subject areas included radiological physics; dosimetry; and radiation effects on protein molecules, DNA, cells (genetic and cytogenetic), mammalian systems, whole animals, and man. Five papers were abstracted previously and appeared as NSA 19: 46339, 46770 and 20: 1621, 8724, 41187. (M.M.B.)

For abstracts of individual papers see: 12817–12825, 12835–12839, 12857–12860, 12891–12894, 12922–12936, and 12944.

12922 MORTALITY DETERMINANT IN NONUNIFORM EXPOSURES OF THE MAMMAL. Bond, V. P.; Robinson, C. V. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-gen-16. Radiat. Res., Suppl. 7, 265-75(1967). (BNL–9549).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

A model to deal with the problem of evaluating the effects of nonuniform dose distribution in animals exposed to penetrating radiation in the $LD_{50(30)}$ (hematological syndrome) range was developed and tested on the basis of available data in the literature. The model took into account the absorbed dose to subunits of bone marrow, the distribution of bone marrow (stem cells) in the body, and the presumed exponential nature of the dose-survival curve for bone marrow stem cells. The surviving fractions of stem cells in the entire body, as calculated on the basis of the model and from available mortality data, were approximately the same at the $LD_{50(30)}$ for uniform and nonuniform exposure. A basis for a distribution effectiveness factor (DEF) to take into account differences in macrodistribution of dose, similar in concept to the relative biological effectiveness factor (RBE) that takes into account differences in microdistribution in dose, is presented. (auth)

12923 USE OF A DEUTERON MICROBEAM FOR SIMULATING THE BIOLOGICAL EFFECTS OF HEAVY COSMIC-RAY PARTICLES. Curtis, Howard J. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res., Suppl. 7, 250-7(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

The ionization produced by heavy cosmic-ray particles is highly concentrated along single tracks, and the microscopic dose within these tracks is very high, although the overall dose rate in outer space would be very low. These particles cannot be produced now in the laboratory so a microbeam of deuterons was developed which simulates the ionization patterns of these particles. When this microbeam was used on mice, it was found that this type of radiation caused very little damage to the brain or eye and presumably in the other vital organs of the body. However, it did cause graying of hair. It was concluded that this type of radiation does not constitute a serious hazard for space flight. (auth)

12924 LENS OPACIFICATION IN MICE EXPOSED TO FAST NEUTRONS. Bateman, John L.; Bond, Victor P. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res., Suppl. 7, 239-49(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Early minute lens opacities were examined periodically after the exposure of mice to low and intermediate doses of fast neutrons at either of two discrete energies, or to 250-kVp x rays. Data were gathered and analyzed by revised techniques. The anterior and posterior regions of the lens were considered as two separate systems. Results in each region suggested an approximate cataractogenic efficiency of 10 for neutrons of either 0.43 MeV or 1.80 MeV, as compared to 250-kVp x rays. Neutron doses of 1 rad appeared to produce definite opacification, which, however, reached a plateau not seen with higher radiation doses. (auth)

12925 TIME-INTENSITY DATA IN SOLAR COSMIC-RAY EVENTS: BIOLOGICAL DATA RELEVANT TO THEIR EFFECTS IN MAN. Sweet, W. H.; Kjellberg, R. N.; Field, R. A.; Koehler, A. M.; Preston, W. M. (Massachusetts General Hospital, Boston). Radiat. Res., Suppl. 7, 369-83(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

The characteristics of the emission of heavy particles in the major solar cosmic-ray events of the last sunspot cycle are summarized. Attention is drawn to the probability of the less lethal effect of continuous irradiation for hours during a flare, and to the special protective effect of the body itself for an adequate amount of the vertebral bone marrow at the energy ranges in question, probably enough to minimize the problem with respect to the formed elements of the blood. The same may be true of the liver, kidneys, gut, pancreas, and adrenal glands. Only the important lateral cerebral mantle of gray matter was in a relatively exposed position and might conceivably profit by a special helmet to shield it. The results of irradiation at the Bragg peak of the pituitary gland in 121 patients with diabetic retinopathy are summarized. Salient points in terms of space radiation problems are that 12% of 92 patients failed to develop hypopituitarism on doses effective for the remainder, and that 30% of 92 patients developed extraocular pareses, usually transient. Both sets of facts emphasize again the well-known substantial individual differences in radiation sensitivity and demonstrate that this principle applies as well to protons. It is clear that there is an extreme paucity of data relevant to the peculiar space radiation hazards for man. (auth)

12926 EFFECTS OF ACUTE EXPOSURE TO HIGH-ENERGY PROTONS ON PRIMATES. Taketa, S. Tom (Ames Research Center, Moffett Field, Calif.); Castle, Bruce L.; Howard, Wayne H.; Conley, Charles C.; Haymaker, Webb; Sondhaus, Charles A. Radiat. Res., Suppl. 7, 336-59(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

The biological effectiveness of high-energy graphite-attenuated protons was compared with that of ^{60}Co γ radiation in monkeys given 4π whole-body irradiation. The end points were mortality, clinical observations, necropsy, and microscopic findings, and changes in body weight and peripheral blood erythrocytes and leukocyte counts. Data based on midpoint air dose, midpoint tissue dose, and average body dose were used for the evaluation. Protons appeared to be as effective or slightly more effective than γ rays when the comparisons were based improperly on midpoint air dose, but less effective when based properly on absorbed tissue dose. The general appearance, symptoms of radiation syndrome, and pathological changes were essentially similar in the two irradiated groups. Silver impregnation of the brains of 15 of the animals revealed glial activation in most of the animals. This was considered a radiation effect. (auth)

12927 ACUTE SOMATIC EFFECTS IN PRIMATES OF PROTONS TO 400 MeV. Lindsay, I. R.; Dalrymple, G. V. (School of Aerospace Medicine, Brooks AFB, Tex.). Radiat. Res., Suppl. 7, 330-5(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

The results of experiments performed with 32-MeV, 55-MeV, 138-MeV, 250-MeV, and 400-MeV protons using three different cyclotron facilities are reported. The highly penetrating protons did not produce new or unusual effects in Macaca mulatta. The only significant clinical departure from experience with 2-MeV x rays was increased severity of gastrointestinal and hemorrhagic disorders. RBE's based on 30-day mortality were approximately 1. (M.M.B.)

12928 PROTON-IRRADIATION EFFECTS IN PRIMATES. Zellmer, Robert; Culver, James; Pickering, John E. (School of Aerospace Medicine, Brooks AFB, Tex.). Radiat. Res., Suppl. 7, 325-9(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Investigation of the effects of protons on Macaca rhesus was initiated in order to provide data on which to base space capsule shield design. A comparison of the effects of 730-MeV protons and 910-MeV α particles on the eye of the primate was made and the threshold doses for certain end points were determined. RBE's of 0.7 to 2.0 for protons and 0.5 to 2.0 for α particles were calculated although a clinical impression of a milder α particle effect was formed. Experiments with whole-body irradiation were also performed. The data were not com-

pletely analyzed but some preliminary calculations and observations were made. Using log dose, a $LD_{50(30)}$ of 393 rads was calculated with 95% confidence limits of 341 to 454 rads. For straight dose, a $LD_{50(30)}$ of 403 rads was calculated with 95% confidence limits of 338 to 468 rads. (M.M.B.)

12929 ACUTE EFFECTS OF HIGH-ENERGY PROTONS AND ALPHA PARTICLES IN MICE. Ashikawa, J. K. (Los Angeles County General Hospital. Loma Linda University School of Medicine, Los Angeles. Univ. of Southern California, Los Angeles); Sondhaus, C. A.; Tobias, C. A.; Kayfetz, L. L.; Stephens, S. O.; Donovan, M. Radiat. Res., Suppl. 7, 312-24(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Fractionated doses of 730-MeV protons and 910-MeV α particles have been used to determine the change in radiosensitivity of normal mouse intestine. A total dose of 940 rads was given to the whole body in a single acute dose or in two equal fractions. In both proton- and α-particle-irradiated animals, relative to the single-dose groups, a five- to sixfold decrease in gut death was noted when the two doses were separated by 3 hours. When the doses were separated by increasing intervals of time, two radiosensitive periods were observed. These agree well with the findings previously reported with x rays. Dose fractionation apparently does not affect hematopoietic tissues in the same way as gut tissues, since marrow death was not altered at these dose levels. The relative effectiveness of 730-MeV protons, degraded to 200 MeV with copper or carbon absorbers, is not significantly different from the undegraded beam. The RBE for LD_{50} at 6 days was 0.98, and 0.79 at 30 days for carbon; for copper the 6-day RBE value was 0.95, and 0.75 at 30 days. The corresponding RBE values of the undegraded beam were 0.96 and 0.75. The biological effect of secondary particles in the degraded beams was negligible in mice. The relative effectiveness of high-energy protons and α particles for induction of dominant lethals by spermatogonial irradiation has been determined. Based on the rates of abnormal embryos to total implantations the RBE of 730-MeV protons and 910-MeV α particles, relative to 250-kVp x rays, appeared to be about unity. (auth)

12930 INJURY ACCUMULATION AND RECOVERY IN SHEEP DURING PROTRACTED GAMMA IRRADIATION. Leong, G. F.; Page, N. P.; Ainsworth, E. J.; Hanks, G. E. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., Suppl. 7, 288-93(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Sheep were subjected to a single sublethal dose of γ radiation; the LD_{50} was determined at subsequent time intervals. At a rate of 3.6 R/hr, injury accumulated linearly with the total dose. A dose rate of 0.5 to 0.95 R/hr with a total dose of 165 R did not reduce survival. When rates were increased to 1.85 and 3.9 R/hr, respectively, 45% (75 R) and 63% (104 R) of the remaining injury was detected immediately following the protracted exposure. It appeared that the threshold exposure rate for injury accumulation was between 1.0 and 1.85 R/hr. Assuming that recovery rate was linear during protracted exposure, recovery rates of 0.96 R/hr for dose rates of 1.85 R/hr and 1.9 R/hr for dose rates of 3.6 R/hr were calculated. Preliminary results indicated that little or no recovery occurred during the first seven to 11 days after acute x or γ irradiation. Rapid recovery followed and a transient state of radioresistance was reached. (M.M.B.)

12931 KINETICS OF INJURY AND REPAIR TO MAMMALIAN TISSUE BY HIGH-LET RADIATION. Fowler, J. F. (Hammersmith Hospital, London). Radiat. Res., Suppl. 7, 276-87(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

The short-term intracellular recovery from sublethal injury, occurring within one cell cycle, was shown in a number of cell systems to decrease with increasing total LET (LET_∞) of the radiation. It was suggested that this was due to the increasing proportion of single-hit (= single-track) killing with increase of LET_∞. Experiments are described on the skin of mice irradiated with single or divided doses of fast neutrons, or with x rays or electrons. For fast neutrons generated by 15-MeV deuterons on beryllium (maximum energy 18 MeV, modal energy 6 MeV), this intracellular recovery was about one-half to two-thirds as great as for a dose of x rays producing the same cell killing. The rate of appearance and subsequent healing of acute skin reactions was studied as a measure of cellular repopulation rate. It was demonstrated that there was no significant difference in these rates after fast neutron or x irradiation. (auth)

12932 A COMPARISON OF AVERSIONS INDUCED BY X RAYS, TOXINS, AND DRUGS IN THE RAT. Garcia, John; Koelling, Robert A. (Harvard Medical School, Boston. Massachusetts General Hospital, Boston). Radiat. Res., Suppl. 7, 439-50(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

A number of test stimuli were paired with a series of three x-ray exposures (54 R each) during a daily drinking period, and subsequently the capacity of the test stimulus to depress water intake in rats was tested. Gustatory stimuli (vinegar, saccharin) acquired strong aversive properties, while a distinctive compartment (visual, auditory, and tactual cues) acquired none. An intermediate effect on fluid intake was established to an olfactory stimulus (perfume). Aversions were established for novel or familiar fluids, preferred or nonpreferred fluids, flavored or unflavored water. Apparently radiation-induced aversions are a form of discrimination learning, easily established for gustatory and olfactory cues, but much more difficult to establish for visual, auditory, or tactual cues. A similar pattern of avoidance reactions was observed following ingestion of a toxin (lithium chloride) and a drug injection (apomorphine hydrochloride) which produce gastrointestinal malaise. (auth)

12933 CLINICAL STUDIES OF RADIATION EFFECTS IN MAN. PRELIMINARY REPORT OF A RETROSPECTIVE SEARCH FOR DOSE-RELATIONSHIPS IN THE PRODROMAL SYNDROME. Lushbaugh, C. C. (Oak Ridge Inst. of Nuclear Studies, Tenn.); Comas, Frank; Hofstra, Ruth. Radiat. Res., Suppl. 7, 398-412(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

The dose-response relations for anorexia, nausea, vomiting, fatigue, diarrhea, and death were determined retrospectively without correction for natural incidence of these responses in 100 patients, 93 of whom suffered at the time from various blood dyscrasias. The effective dose (ED_{50}) for the least prodromal response, anorexia, was determined to be 82 ± 32 epigastric rads. The $LD_{50(60)}$, uncorrected for nonradiologic deaths, was found to be 281 ± 44 rads as from a midline exposure of 425 R. (auth)

12934 HISTOLOGY OF THE SURGICAL RADIOLESION IN THE HUMAN BRAIN AS PRODUCED BY HIGH-ENERGY PROTONS. Mair, William; Rexed, Bror; Sourander, Patrick (Univ. of Uppsala). Radiat. Res., Suppl. 7, 384-9(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

It was possible, by using stereotaxic methods and crossfire technique, with high-energy protons to destroy a small selected region of the human brain such as the spinothalamic tract in the midbrain. The irradiated region was sharply demarcated. It was ovoid in shape with a crenated border. Destruction of myelin sheaths, axons, astrocytes, and oligodendroglia occurred in the irradiated region, and there were some tiny perivascular hemorrhages in it. Nuclear debris and collections of macrophages were found at the edge of the necrosis. Little proliferation of astrocytes was seen around it 9 weeks after irradiation. The changes were exactly similar to those seen in goats 7 and 4 weeks after irradiation with the same dose and by the same technique. Tiny, discrete, rounded zones of necrosis were seen in man just rostral to the confluent necrosis, and a similar change was seen in the goats irradiated by this method. They were presumably the result of intersecting beams as they passed to the center of irradiation. (auth)

12935 SPACE-FLIGHT-RELATED STRESSES ON THE CENTRAL NERVOUS SYSTEM. Schoenbrun, R. L.; Adey, W. R. (Univ. of California, Los Angeles). Radiat. Res., Suppl. 7, 423-38(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

Computerized methods for precise specification of different states of central nervous system function are presented. The effects of centrifuging acceleration, whole-body vibration, and focal brain irradiation on cerebral electrical activity are discussed with special emphasis on temporal lobe structures. (auth)

12936 EFFECT OF HIGH-ENERGY PARTICLE IRRADIATION ON THE VESTIBULAR MECHANISM IN RABBITS. McDonald, Larry W. (Univ. of California, Berkeley). Radiat. Res., Suppl. 7, 451-8(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924–(Suppl.).

(1) A method of irradiating the inner ear with minimal exposure of the paraflocculus lobe of the cerebellum has been presented. A 910-MeV α-particle beam was used. (2) A low-dose effect, requiring 1 to 2 weeks free of strong vestibular stimulation for its appearance, has been observed. (3) A higher-dose effect appears regardless of strong vestibular stimulation. (4) Further studies in progress have been mentioned. (auth)

Radiation Effects on Plants

Refer also to abstracts 12781–12783, 12835, 12836, 12838, and 12840.

12937 (CONF-660344-1) DISPOSITIF C.O.I.N.: CANAL OUVERT POUR IRRADIATION AUX NEUTRONS; APPLICATIONS BIOLOGIQUES. (C.O.I.N. Arrangement: Open Channel for Irradiation with Neutrons; Biological Applications). Fourcy, A.; Pleyber, G.; Richard, B. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar. 14, 1966 22p. (In French). (Pi(NT)-563/72).

From Colloquium on Experimental Morphology Conference, Grenoble, France.

An open neutron irradiation channel was constructed for the neutron irradiation of plants in a γ flux as low as possible. The design and construction of the C.O.I.N. arrangement is described in some detail. The neutron dose calculation, the γ radiation measurement and the neutron flux measurement are described. An approximation evaluation is made of a mixed dose of reactor neutrons and of γ radiation by means of barley seeds. Preliminary measurements were made to compare the biological measurements and the physical dosimetry. The results obtained show the effect of neutrons and permit the comparison of neutron irradiation with γ irradiation. The biological efficiency factor of neutrons was found to be seven as opposed to the generally accepted value of ten. (J.S.R.)

12938 (NP-17124) DOSAGE DU STRONTIUM TOTAL DANS LES VEGETAUX. COMPARAISON DE L'ANALYSE PAR ACTIVATION ET DE LA PHOTOMETRIE DE FLAMME. (Determination of Total Strontium in Vegetables. Comparison of Activation Analysis with Flame Photometry). Barbe, Robert (Grenoble Univ. (France). Faculte des Sciences). June 18, 1966. 22p. (In French). Dep.

Thesis.

The determinations of Sr in vegetables by activation analysis and flame photometry were compared. The two methods gave comparable results. Flame photometry is the simpler method, but activation analysis requires only a small sample and permits a simultaneous determination of other elements. Examples are given of Sr determinations in poplar leaves, salad leaves, leaves of Monstera delciosa, Salvinia natans, and Lemna minor. (J.S.R.)

12939 (N-67-29205, pp 43-8) INCREASING THE RADIORESISTANCE OF THE POTATO UNDER CONDITIONS OF ANOXIA. Dadykin, V. P.; Shaydorov, Yu. I.; Gertsuskii, D. F.; Skukina, I. S.; Nikishanova, T. I.; Nikitina, I. V.; Finogenova, L. I. Translated from Kosm. Biol. Med., 1: No. 1, 36-9(1967).

Potato seedlings were exposed to gamma radiation during space flight, and the protective effects of an oxygen-free environment were studied. There was little effect with low doses (500 to 1500 rad). With high doses (3000 to 5000 rad) the protective effects were very distinct. The potato yield from plants irradiated under anoxic conditions was increased. (H.L.W.)

12940 ELECTRON MICROSCOPY ANALYSIS OF THE ACTION OF VARIOUS ULTRAVIOLET SPECTRUM SECTIONS ON TOMATO AND CUCUMBER PLANT PHOTOSYNTHESIS MECHANISM. Selga, M. P.; Tageeva, S. V. (Inst. of Biology, Riga). Latv. PSR Zinat. Akad. Vestis, No. 8, 92-9(1967). (In Russian).

The effects of ultraviolet radiation on plants depends on its wave length. Long-wave ultraviolet radiation with maximum effect at about 365 mμ stimulates the growth and development of the plants. Short-wave ultraviolet radiation with maximum at about 265 mμ causes an inhibition of the growth and development of plants. Supplementary irradiation of the seedlings with ultraviolet radiation causes a change in the leaf structure. Long-wave ultraviolet radiation improves the formation of the columnar parenchyma and promotes the formation of porous spongy parenchyma. Short-wave ultraviolet radiation does not damage the upper parenchyma of the leaf, but causes a transfer of the chloroplasts to the periphery of the cell with simultaneous decrease in their quantity in the cell. The number of chloroplasts of the adult, responsible for the photosynthetic activity of the cells, is not constant. Long-wave ultraviolet radiation causes an increased formation of lamellar systems of chloroplasts, the formation of new active intracellular surfaces inside the chloroplasts, and subsequent fission along the axis of the chloroplasts with preservation of the lamellar system and the mechanical fission of chloroplasts with very large starch grains. Short-wave ultraviolet radiation causes destruction of the chloroplasts during which the casing of the chloroplasts is broken by means of intergranular lamellae and grains are found with great stability. (tr-auth)

12941 EFFECT OF IONIZING RADIATION UPON THE PROPERTIES, YIELD, AND QUALITY OF INDUSTRIAL CAYENNE (CAPSICUM ANNUUM VAR. LONGUM AND GROSSUM). Petijevic, O.; Jovanovic, B. Rad. Poljopr. Fak. Univ. Sarajevu, 13: No. 15, 3-20(1964). (In Slovak).

The effects of ionizing radiation on the quality and production of cayenne were studied. Dry seeds of sour and sweet industrial cayenne received 2000, 4000, and 8000 R doses, while germinated seeds received 200, 400, 800, and 1000 R doses. With increased doses there was a slight increase in total germination. Irradiation of the germinated seeds shortened the fruiting time by 9 to 12 days, increased the number of aberrant sour cayenne plants, increased the yield and fruit weight (except at the highest dose), and decreased the amount of pericarp. Content of dry matter in the pericarp of sour cayenne was higher when produced from dry seed than from germinated seed, but the converse was true in sweet cayenne. The effects of irradiation on the capsaicin content of the pericarp varied with both dose and type of seed. (E.R.B.)

12942 SEED TREATMENT AND PHYSICS. K'o Hsueh Ta Chung, No. 5, 32(May 1963). (In Chinese).

Application of principles in physics to the treatment of seeds often helps the crop to a considerable extent. Ultraviolet rays help spot moisture-damaged wheat seeds because such seeds appear yellow in uv light instead of green as normal seeds are. High frequency current treatment of sunflower seeds ensure harvest in a short period of one and one half months after planting. Ultrasonic treatment of potatoes promote production and increases output, as does x ray treatment of turnips. After soaking in radioactive solution for a period, navy beans were 34 per cent more productive than untreated ones. (JPRS)

12943 THE EFFECT OF HEAVY PARTICLES FROM $^{10}B(n,\alpha)^{7}Li$ AND $^{6}Li(n,\alpha)^{3}H$ REACTIONS ON THE GROWTH OF BARLEY SEEDLINGS. Hori, Shiro; Ujihara, Akio; Mori, Shigeyuki; Kawasaki, Toshio. Annu. Rep. Radiat. Center Osaka Prefect., 7: 90-3(1966).

The biological effectiveness of heavy particles from $^{10}B(n,\alpha)^{7}Li$ and $^{6}Li(n,\alpha)^{3}H$ was observed for seedling growth in barley. Barley seeds that were previously immersed in aqueous solution of boric acid and lithium chloride with 500 and 250 parts per million concentration respectively were exposed to thermal neutron in nuclear reactor. The content of the boron and lithium in barley seeds increased progressively as the concentration of solution (25 to 500 parts per million). Distribution of boron in germinated seed was analyzed. The embryo, that was treated with 500 parts per million boric acid solution, had a considerably high content of boron compared with endosperm and seed coat. From this fact, it may be expected that the embryo having a large amount of boron presents a more striking biological effectiveness when irradiated to thermal neutrons. The influence of absorption of boron and lithium into seeds on seedling growth was not recognized. The reduction of seedling growth caused by thermal neutron irradiation was large in the boron absorbed seeds at the dose of 5×10^{11} and 10^{12} nth/cm^2. Similar results are obtained for the decreasing of survival rate in seedlings. It may be concluded from present experiments that the more sensitivity to thermal neutron in boron absorbed barley seeds results from the emitted energy by $^{10}B(n,\alpha)^{7}Li$ reaction within embryo. (auth)

12944 EFFECTS OF SONIC IRRADIATION ON YEAST. Burns, V. W. (Univ. of California, Davis). Radiat. Res., Suppl. 7, 231-8(1967).

From Workshop Conference on Space Radiation Biology, Berkeley, Calif., Sept. 7–10, 1965. See CONF-650924-(Suppl.).

Under certain conditions sublethal sonic irradiation will prevent accumulation of ureidosuccinate (US) in the yeast S 1237 during irradiation. On termination of sonication US again accumulates at a normal rate. Under identical irradiation conditions free histidine leaks out of the cells and protein synthesis declines; these effects were not immediately reversed on termination of sonication. The same treatment did not affect the uptake and incorporation of adenine or the pool of purine nucleotides. The uptake and/or retention of aspartate, a precursor of ureidosuccinate, was reduced by sonic irradiation. The simplest explanation consistent with these facts is that the cell membrane may become more permeable to certain small molecules during sonic irradiation. At a certain critical intensity of sound some kinds of small molecules may leak out of the cell; other kinds and large molecules cannot. The passage of molecules into the cell may also be affected. The time required to return to normal behavior after irradiation seemed to depend on the molecular species or process affected. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 12781, 12806, 12828, and 12840.

12945 (NP-17125) IRRADIATIONS CONTINUES AUX RAYONS X DE CULTURES DE CHLORELLES. (Continuous Exposure of a

Culture of Chlorelles to X Rays). Arnaud, Maurice (Grenoble Univ. (France). Faculte des Sciences). [Oct. 14, 1966]. 24p. (In French). Dep.
Thesis.

Chlorella cultures were irradiated at doses of x radiation at 1750, 3000, and 5000 rad/day continuously during the cellular cycle. A study was made to determine if during the course of various cellular cycles injury not incompatible with cellular multiplication would be transmitted to daughter cells. In this case the cellular line ought to become more and more radiosensitive. The studies showed that there was a sensitization of the cells by continuous irradiation. There was an indication that the total dose received by the cellular line plays an important role which lead to the supposition that the accumulation of nonlethal damage was responsible for this radiosensitization. (J.S.R.)

12946 PRACTICAL METHODS USABLE FOR MEASUREMENT AND EVALUATION OF UVC IRRADIATION EQUIPMENTS, PART II. Oberdoerster, F.; Thielecke, K.-H. (Humboldt Univ., Berlin). Z. Gesam. Hyg. Ihre Grenzgeb., 11: 817-28 (Nov. 1965). (In German).

The effects of uv irradiation on populations of Escherichia coli, Bacillus pseudoanthracis spores, and Aspergillus orycae were studied. The bactericidal effects increased with increased concentrations of cells in suspension. The exposures required for 90% kills ranged from about 36,900 to about 22,900 μw sec/cm^2 for counts of 2000 to 8000/ml. Irradiation times ranged up to 60 sec. Less than 10,000 μw sec/cm^2 killed 90% of the Escherichia coli, but more than 30,000 μw sec/cm^2 were required to kill 90% of the B. pseudoanthracis spores and Aspergillus. The main factors that influence effectivity of uv irradiation to kill microorganisms are the volume of the aqueous or gaseous medium to be irradiated, and the microbiocidal effectivity of the irradiation source. Probably the major consideration in sterilization by uv irradiation is the relative high resistance of the spore forming organisms, which will affect the amount of irradiation required to be effective. (BBB)

12947 THE ROLE OF HOST-CELL REPAIR IN LIQUID-HOLDING RECOVERY OF UV-IRRADIATED ESCHERICHIA COLI. Harm, Walter (Southwest Center for Advanced Studies, Dallas). Photochem. Photobiol., 5: 747-60 (Sept. 1966).

It is reported that liquid-holding recovery (LHR) of uv-irradiated E. coli cells involves basically the same type of dark repair which causes reactivation of phage and which results in much increased survival of the cells themselves (host-cell reactivation (HCR)). Liquid-holding recovery is very small in the 2 HCR(–) strains B syn$^-$ and B_{s-1}, but occurs to larger but different extents in the 3 HCR(+) strains B, B/r, and B/r (λ). Liquid-holding recovery is inhibited if the liquid contains caffeine or acriflavine, both of which are known to inhibit HCR. The results indicate that most of the LHR effect, if not all, occurs during the liquid holding, rather than under growth conditions after liquid holding. It is assumed that the holding itself allows a prolonged time for, and therefore an enhancement of, HCR. Thus, LHR can be observed only where otherwise HCR of repairable uv damage would be incomplete, and different extents of LHR, as observed in the 3 HCR(+) strains, reflect different extents of incompleteness of HCR. It is concluded that the repairable uv hits which are not fully repaired by HCR are predominantly those concerned with the extra uv sensitivity of the strains B and B/r (λ), relative to B/r. (BBB)

Radiosterilization and Radiopreservation

12948 EFFECTS OF RADIATION, HEATING, AND STORAGE ON VOLATILE CARBONYL COMPOUNDS IN CLAM MEATS. Gadbois, D. F.; Mendelsohn, J. M.; Ronsivalli, L. J. (Bureau of Commercial Fisheries, Gloucester, Mass.). J. Food Sci., 32: 511-15 (Sept.-Oct. 1967).

The development of volatile carbonyl compounds in clam meats stored at 33 to 35°F was determined by gas chromatography. When air-packed samples were γ irradiated (0.35 Mrad) and/or heated, the concentration of carbonyl compounds increased immediately, except for some low-boiling compounds that were reduced in concentration when the samples were heated. Storage of nonirradiated, air-packed samples at 33 to 35°F caused a gradual increase in the concentration of volatile carbonyls until about the 20th day at which time the trend was reversed. When clam meats were vacuum-packed, the effects of 0.45 Mrad irradiation, heating, and storage were minimized. The pattern of volatile carbonyls in irradiated fresh clams was similar to that found in nonirradiated clams stored at 33 to 35°F for 20 days. The volatile monocarbonyl compounds, C_2 to C_7 and diacetyl detected, evidently do not play a major direct role in the changing quality of stored clam meats. (BBB)

12949 POSSIBILITIES OF USING IONIZING RADIATION IN THE CONTROL OF INSECTS IN HUNGARY. Nagy, Barnabas. Atomtech. Tajek., 10: 1-6(1967). (In Hungarian).

The uses of ionizing radiation and radioisotopes in entomology are reviewed. Radioisotope application to the study of food dispersion, hibernation, and migration of insects is considered. Techniques for eradication of insects by irradiation are compared, and the application of sublethal doses in the sterile male flooding method for control of May cockchafers in Hungary is discussed. (tr-auth)

12950 TREATMENT OF DEHYDRATED POTATOES. (to Salada Foods Ltd.). British Patent 1,094,428. Dec. 13, 1967. Priority date Jan. 5, 1966, United States.

Dehydrated potatoes were γ-irradiated at various doses, placed in distilled water, and heated to 200°F. Color, flavor, texture, and rehydration were recorded. Irradiation reduced the cooking time, but the color and flavor were adversely affected. These undesirable effects were reduced by irradiating the potatoes at a temperature below –100°C. Either β or γ radiation could be used at doses between 1 and 10 megarads. Rehydration time was reduced by this technique. Techniques for irradiation at low temperatures are described. (H.L.W.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 13566 and 13592.

12951 (NYO-2731-3) PHASE EQUILIBRIA AND SPECIFIC VOLUMES OF LIQUID METALS AN_4 ALLOYS. Report No. III. Kanda, Frank A.; Keller, Douglas V. (Syracuse Univ. Research Inst., N. Y. Dept. of Chemistry). May 1964. Contract AT(30-1)-2731. 23p. Dep. CFSTI.

A phase diagram is presented for the Ca–Li system. An automatic vacuum type densimeter was designed to use in measuring dynamic densities. A gettering argon atmosphere was employed. The instrument is being used with metallic binary systems, pure metals and paralleling organic systems. Densities have been determined for isoamyl alcohol-glycerol systems, phenol-H_2O systems, Hg–Tl, and bismuth. Modifications are described for the high temperature calorimeter. (F.S.)

12952 EQUIPMENT FOR THE STUDY OF WEAR UNDER CONDITIONS OF OSCILLATORY RELATIVE MOTION IN LIQUID SODIUM. De Gee, A. W. J.; Commissaris, C. P. L.; Chirer, E. G.; Bogers, A. J. (Metal Research Inst., Delft, Netherlands). pp 415-26 of Alkali Metal Coolants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria. See STI/PUB-143; CONF-661110.

Equipment for study of wear in liquid sodium under conditions of oscillatory relative motion of small amplitude (fretting) is described. With this equipment experiments can be performed at temperatures up to 750°C in sodium with controlled oxygen content. Torsional vibration in the plane of contact of two test specimens or oscillatory motion normal to the plane of contact or combinations of these may be applied. With this equipment fretting experiments are performed with steel X 8 Cr Ni Mo V Nb 16/13, Inconel 625 and the vandium alloys V-20 Ti and V-5 Ti-20 Nb, at different temperatures and oxygen content. (auth)

12953 EVALUATION OF IMPURITY MONITORING DEVICES TESTED IN A DYNAMIC SYSTEM. Petrek, J. P.; Kovacic, E. C. (Atomic Power Development Associates, Inc., Detroit). pp 489-503 of Alkali Metal Coolants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria. See STI/PUB-143; CONF-661110.

Several devices for the detection and monitoring of impurities in sodium are being evaluated in a dynamic test loop. The loop consists basically of a main loop and test loop and is equipped with cold trap, hot trap, plugging meter, sampling station, impurity injection port, and with the various impurity monitoring and purification devices that are being evaluated. In the initial test evaluation of the rhometer, impurities were injected by raising the loop cold-trap temperature, and the impurity level was determined by utilizing plugging temperatures and sodium monoxide solubility data. On this basis, the rhometer response was approximately 0.008% resistivity per ppM of monoxide. Subsequent tests were performed by directly injecting specific impurities including Na_2O, NaOH, NaH, Na_2CO_3 and H_2O into the loop. The rhometer response to the specific impurity injections, except for H_2O, was substantially less than had been previously observed. The rhometer response for Na_2O injection was a factor of 10 less. More recently, evaluations of the meters with sodium monoxide injections tend to confirm the preliminary results. Four electrolytic oxygen cells are being evaluated in the loop. In the initial semi-quantitative tests, the meters were observed to respond to the predicted direction to specific injections of sodium monoxide and water. The data indicate a large noise-to-signal ratio which primarily has been attributed to changes in ambient temperature. Preliminary tests show that significant step changes in the cell output result from temperature cycling and also from the presence of gamma radiation. In conjunction with the evaluation of the rhometers and oxygen meters, test programs are being conducted to evaluate both the plugging meter, and sampling and chemical analysis as means of impurity monitoring. (auth)

12954 FUEL AND FERTILE MATERIALS. Reactor Mater., 10: 203-16(Winter 1967-68).

Unalloyed uranium and alpha- and gamma-phase uranium alloys are discussed. Plutonium and thorium development as nuclear fuels is summarized. The properties and behavior of dispersions, uranium and thorium oxides, and carbide and nitride fuels are reviewed. The oxidation of uranium dioxide by steam and irradiation effects in fuel materials are outlined. A listing of 66 references is included. (J.C.W.)

12955 REACTOR MATERIALS. Volume 10, Number 4. Simons, E. M.; Porembky, S. W. Jr.; Keller, D. L. (eds.). One of the Four Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Columbus, Ohio, Battelle Memorial Inst., Winter 1967-68. 66p. GPO $0.70.

A review of fuel and fertile materials, moderator and control materials, cladding and structural materials, and special fabrication techniques for reactor materials is given. Individual abstracts follow. (J.C.W.)

12956 SPECIAL FABRICATION TECHNIQUES. Reactor Mater., 10: 257-66(Winter 1967-68).

Melting and casting processes for cast and wrought materials are described and the fabrication process of cast structures is explained. A review on the progress made in powder metallurgy summarizes the processes. A summary of pressure bonding, plating, explosion forming, welding, and brazing techniques is given. Ultrasonic techniques are applied for the testing of reactor materials. Other nondestructive methods are developed and summarized. A listing of 51 references is included. (J.C.W.)

12957 CLADDING AND STRUCTURAL MATERIALS. Reactor Mater., 10: 225-56(Winter 1967-68).

Corrosion of zirconium alloys, aluminum alloys, stainless steels, nickel-base alloys, and refractory metals is discussed corrosion by nonaqueous liquids sodium, indium, and organics is summarized. Nickel-steam reactions and isothermal steam-oxidation experiments are described. The temperature coefficient of reaction for stainless steel and Zircaloy-4 is shown. The effect of neutron irradiation on the mechanical properties of Incoloy 800 is discussed. Radiation effects in structural vanadium alloys and pressure vessel steels are summarized. The metallurgy of refractory metals niobium, molybdenum, tantalum, tungsten, and chromium is presented. The effects of cold work on the hardness of SAP alloys containing various amounts of Al_2O_3 is illustrated. The metallurgy of common cladding and structural materials such as zirconium, zirconium alloys, pressure vessel steel, stainless steels, cobalt-base alloys, and nickel-base alloys is discussed. The properties of nonfuel refractory materials and concrete applications in reactor technology are reviewed. A listing of 147 references is included. (J.C.W.)

12958 MODERATOR AND CONTROL MATERIALS. Reactor Mater., 10: 217-24(Winter 1967-68).

The development of graphite, beryllium and beryllium alloys, beryllium oxide, and titanium hydride for use as reactor moderator materials is summarized. The heats of formation of the hydrides of rubidium and cesium are determined and the hydrides and deuterides of lithium, potassium, and sodium are calculated. Thermodynamic data on erbium hydride are given. Metals, nonmetals, and dispersion poison materials are analyzed for control materials. A listing of 28 references is included. (J.C.W.)

12959 NEW MATERIALS. Fishlock, D. London, John Murray, 1967. 254p. 45s.

Advances in materials technology are surveyed under the following headings: introduction; anatomy of materials; materials to handle heat; strong materials; composite materials; "living" materials; "hot" materials; "hot" materials; electrically conducting materials; nonconducting materials; semiconducting materials; optical materials; noble materials; materials with holes; materials with memories. (UK)

12960 PROTECTIVE COATINGS FOR METALS. THIRD EDITION. Burns, R. M.; Bradley, W. W. American Chemical Society Monograph Series. New York, Reinhold Publishing Corporation, 1967. 747p. $25.00.

The development of corrosion resistant alloys and protective coatings for corrodible metals is discussed. Information on all types of metallic and organic coatings, their composition, structure, application, and evolution is presented. The mechanisms of corrosion; the production, composition, and character of protective coatings, and their applications; procedures for the preparation of metal surfaces to be coated; corrosion testing methods including

soil and saline atmosphere; and the use of organic inhibitors in corrosion prevention are described. (R.C.K.)

Corrosion and Erosion

Refer also to abstract 14169.

12961 (AWRE-O-44/65) URANIUM COMPATABILITY STUDIES. PART 5. THE INFLUENCE OF pH ON THE URANIUM–WATER REACTION. Baker, M. McD.; Less, L. N.; Orman, S. (Atomic Weapons Research Establishment, Aldermaston (England)). July 1965. 15p. Dep. CFSTI. UK.

The oxidation rate of uranium immersed in water was determined over the pH range from 0.85 to 13.6. The uranium did not exhibit "breakaway" corrosion at either high or low pH and the highest oxidation rates were observed in the pH range from 2.5 to 7. It was concluded that the oxidation of uranium by water does not proceed by an electrochemical mechanism and further evidence is presented in support of the hydroxyl ion as the diffusing entity. (auth)

12962 (BNWL-473) REACTOR FUELS AND MATERIALS DEVELOPMENT PROGRAMS FOR FUELS AND MATERIALS BRANCH OF USAEC DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY. Quarterly Progress Report, April–June 1967. Albaugh, F. W.; Bush, S. H.; Cadwell, J. J.; de Halas, D. R.; Worlton, D. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1967. Contract AT(45-1)-1830. 198p. Dep. CFSTI.

Ten sections on reactor fuels and materials development programs are presented. A separate abstract was prepared for each section. (J.C.W.)

For abstracts of individual sections see: 12472, 12556, 12999, 13035, 13036, 13044, 13060–13062, and 13077.

12963 (RFP-1056) HYGROSCOPICITY OF PLUTONIUM DIOXIDE. Stakebake, Jerry L.; Dringman, Marston R. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Jan. 19, 1968. Contract AT(29-1)-1106. 11p. Dep. CFSTI.

Investigations were initiated to explore more fully the mechanisms of plutonium oxidation and to identify, if possible, the hygroscopic properties of plutonium dioxide. Earlier studies were limited and do not completely define the various interactions within such a system. Quantitative and qualitative data are given on the rate and amount of adsorption of water on plutonium dioxide obtained from experiments at 25, 50, and 75°C. Underlying a reversible physical process, evidence indicates a chemisorption of the water molecules to the surface. Possible adsorption mechanisms are discussed. (auth)

12964 (STI/PUB-143) ALKALI METAL COOLANTS. Proceedings Series. Proceedings of the Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience held in Vienna, 28 November–2 December 1966. (International Atomic Energy Agency, Vienna (Austria)). 1967. 786p. (CONF-661110). IAEA: $16.00; S414,-; £5.13.0; F Fr 78,40; DM 64,-.

46 papers on alkali metal coolants were presented at the symposium. A separate abstract was prepared for each of 15 papers. 31 papers were previously abstracted in NSA. (J.C.W.)

For abstracts of individual papers see: 12952, 12953, 12965–12975, 13041, and 13072.

12965 CORROSION BEHAVIOUR OF STEELS AND NICKEL ALLOYS IN HIGH-TEMPERATURE SODIUM. Thorley, A. W.; Tyzack, C. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 97-118 of Alkali Metal Coolants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria. See STI/PUB-143; CONF-661110.

Findings are summarized on the corrosion behavior of low-alloy steels, austenitic steels and nickel alloys when exposed to sodium under flowing conditions in a pumped loop. The effects of altering various parameters on the rate of mass transfer from steel specimens in the highest temperature portion of the loops have been studied. These include the effect of temperature at 450 to 725°C, the effect of oxygen content of the liquid metal up to a level of approximately 30 ppM by weight (by adjustment of cold-trapping temperature), the effect of sodium velocity in the range 0.5 to 40 ft/s, the effect of specimen position, i. e., any downstream effects, and material variables such as the effect of alloying content in stainless steels and metallurgical conditions, i.e., cold work. A discussion is included of the nature of complex oxide films formed on the surface of steels on initial exposure to sodium, and indications are given of selective loss of alloying elements from the surface of austenitic steels on exposure to liquid metal, as determined by microprobe, chemical and x-ray analysis. Differences between the behavior of iron-rich and nickel-rich alloys are discussed, particularly with respect to different responses to the effect of liquid metal velocity and oxygen level in the sodium. This leads to a general discussion of possible mechanisms of mass transfer and likely rate-determining processes, in particular why the mass transfer rate of iron should be sensitive to the level of oxygen in the sodium. Also discussed are possible reasons for the sharp fall in mass transfer rate of steel above a certain limiting velocity in the loop system in use. Much more remains to be done before a full understanding of the process is gained, and possible experiments are outlined. (auth)

12966 EFFECT OF CERTAIN FACTORS ON THE CORROSION OF STRUCTURAL MATERIALS IN LIQUID SODIUM. Ilinchev, G. (State Scientific-Research Inst. of Material Protection, Prague). pp 131-42 of Alkali Metal Coolants. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria. See STI/PUB-143; CONF-661110.

Loops for the study of corrosion and mass transfer in liquid sodium at approximately 800°C are described. Dynamic and convection loops were used. The amount of oxygen in the sodium was maintained at concentrations up to 3×10^{-3}% in some experiments and at approximately 4×10^{-2}% in others. The effect of Ni, Cr, Mo, Ti, Nb and V on the corrosion of about 30 types of steel in sodium was studied, as was their effect on mass transfer and carbon transfer. Corrosion of pure Ni, Mo, and Ti was also studied. The experiments showed that steels alloyed with Ni and Cr acquire increased resistance to corrosion in sodium with a high oxygen content. Steels with a low or medium content of Cr and Mo show, under the same conditions, a degree of corrosion several times greater; but in liquid sodium with a very low oxygen content these alloy elements have the opposite effect, i.e., corrosion increases with increasing Ni and Cr content, and is slightest in low-alloy steels. Mass transfer in structural steels increases as the oxygen content of the sodium is increased; this is due to the transfer of Fe from hot to cold sections of the material. Carbon can be eliminated from the system by a method similar to that used with oxygen (cold traps), but there is the difference that carbon tends to float on the surface of the sodium to a greater extent. How sodium (and its degree of purity) can affect changes in the mechanical properties of the basic structural steels (austenitic and ferritic steels) is also described. The mechanical properties of stabilized ferritic steels and steels of the Cr and Ni type undergo virtually no change. Attention is given to the influence of temperature on the corrosion of steels in pure sodium and the effect of alloying Ni, Cr, and Mo, in this connection. The relationship between decarbonization of steels and their composition—particularly the content of Cr, Ti, and Nb is considered. The experiments show that low-alloy steels with Cr, Mo, and V are decarbonized to a substantial degree at 400°C. The degree of decarbonization in steels alloyed with 3 to 5% chromium is several times less. Ferritic steels stabilized with Ti or Nb undergo virtually no decarbonization and corrode very little in pure sodium. A comparison is made of the kinetics of the corrosion of structural steels in liquid sodium and in liquid Pb, Bi and Pb–Bi. The experiments showed that the rate of corrosion in heavy liquid metals is influenced hardly at all by circulation velocity (from 1 to 100 cm/s), and it can therefore be assumed that the rate is not determined by diffusion processes. Diffusion processes are assumed, have no effect on corrosion in pure liquid sodium either. Certain experiments in liquid sodium with a high oxygen content suggest, however, that diffusion processes considerably affect the corrosion of low and medium alloy steels. (auth)

12967 PRELIMINARY MODEL FOR THE CARBURIZATION OF STAINLESS STEEL AT HIGH TEMPERATURES IN SODIUM CONTAINING CARBON AT UNIT ACTIVITY. Campbell, C. S.; Tyzack, C. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 159-70 of Alkali Metal Coolants. Vienna, International Atomic Energy Agency, 1967. (TRG-Report-1368; JNPC-SSG/P-(66)100).

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria. See STI/PUB-143; CONF-661110.

A model of the kinetics of carburization of stainless steel is presented. It is assumed that at the surface of the specimen exposed to sodium the equilibrium level of carbon will be set by the carbon activity of the external medium, and that there will be a carbon activity gradient extending inwards to the as yet unaffected matrix, with the growth of the thickness of the carburizing zone being controlled by the diffusion of carbon down the activity gradient. Within this zone, chromium-rich carbide will tend to pre-

cipitate to bring the local level of dissolved chromium into equilibrium with the local carbon activity, as required by the composition of the carbide, and the law of mass action. A diffusion model is set up on this basis and, with the aid of experimental data on carbon pick-up, values for the diffusion coefficient of carbon are calculated which are in reasonable agreement with extrapolated values for carbon diffusion in chromium-free austenite. Earlier models have tacitly assumed homogeneous carbon diffusion through the affected layer and this is believed to be incorrect for reasons that are stated. (auth)

12968 CARBON MASS TRANSFER IN MULTIMETALLIC SYSTEMS CONTAINING POTASSIUM. Semmel, J. W. Jr.; Engel, L. B. Jr.; Frank, R. G.; Harrison, R. W. (General Electric Co., Cincinnati). pp 181-93 of Alkali Metal Coolants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria. See STI/PUB-143; CONF-661110.

To determine whether carbon transfer from ferrous alloys would be impeded by alloying with titanium, which forms a relatively stable carbide, companion capsules of type 316 and 321 stainless steels containing potassium were heated for 1000 hr at 1400°F. Both capsules contained Nb-1Zr alloy specimens which are readily carburized when carbon is present in potassium. The Nb-1Zr specimens were carburized significantly in type 316SS capsules but not in type 321SS capsules, demonstrating that the titanium addition impeded carbon depletion, and that bimetallic systems of type 321SS and Nb-1Zr are more attractive for reducing carbon transfer effects. (Nitrogen transfer was similarly impeded by titanium in type 321SS.) The effects of carburization and nitriding on the mechanical properties of Nb-1Zr are described. Carbon transfer from carbide cermet bearing materials was investigated with isothermal capsules for 1000 hr with potassium at 800, 1200 and 1600°F. Decarburization of the cermets was determined by weight change, x-ray diffraction and chemical analysis of the Nb-1Zr capsule material for evidence of carburization. With commercial, cobalt-bonded WC and other materials containing WC to achieve high hardness, decarburization was observed at 1200 and 1600°F, but not 800°F. This was accompanied by carburization of the Nb-1Zr capsule material and Mo-TZM specimens located near the cermets. X-ray diffraction of the cermets identified new phases, especially elemental tungsten in the surface region, which would alter friction, wear and diffusion bonding characteristics. Conversely, TiC cermets bonded with niobium, tungsten or molybdenum were not decarburized. (J.R.D.)

12969 EFFECTS OF MASS TRANSFER, AND OF CHANGES IN PROPERTIES, ON AUSTENITIC STEELS IN FLOWING SODIUM. Zebroski, E. L.; Young, R. S.; Comprelli, F. A.; Dutina, D. (General Electric Co., San Jose, Calif.). Contract AT(04-3)-189. pp 195-211 of Alkali Metal Coolants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria. See STI/PUB-143; CONF-661110.

Corrosion and mass transfer effects have been investigated over a range of temperature, flow, velocity and sodium compositions believed to be typical of reactor coolant systems. Previous results have been extended to a total of 1.4×10^5 hr of small scale loop operations, at temperatures up to 1300°F. Good agreement has been found for the dependence of mass transfer on temperature and oxygen level, but some unresolved differences remain in velocity and mass flow dependences. The effects of velocity and geometry in larger systems are under investigation in loops designed to mock-up mass transfer effects of large systems. Preliminary results on types 304, 316 and Incoloy 800 indicate varying velocity dependence at moderate and low velocities with pronounced entrance and saturation effects. Intergranular attack has been observed at specific locations in loop austenitic steel piping. Subsequent studies indicate a dependence on oxygen level and stress level. The effectiveness of materials in sodium service depends on the changes in mechanical properties due to compositional and structural modifications, as well as the loss or gain of material by mass transfer. Techniques for systematically determining the influence of such conditions on several critical alloy properties while exposed to representative flowing sodium environments are described. The possible effect of large heat fluxes on quantitative mass transfer rates is hypothesized and initial results of short-term experiments are discussed. The analysis of trace impurities in sodium continues to pose problems because of the limited correlations found so far between elemental trace analysis and the behavior of coupons of samples. Progress in methods to attain high sensitivity and identification of trace compounds using three improved methods is reported. Observations on the relationship of localized carbon analysis to the behavior of plugging meters are reported. The occasional occurrence of severe localized attack of austenitic steels during in-reactor tests is noted, and some of the observations and hypotheses are discussed. (auth)

12970 INVESTIGATION OF TUBE WASTAGE CAUSED BY SMALL LEAKS OF WATER IN SODIUM-HEATED STEAM GENERATORS. Muenchow, H. O.; Chase, W. L. (Atomic Power Development Associates, Inc., Detroit). pp 273-93 of Alkali Metal Coolants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria. See STI/PUB-143; CONF-661110.

Examination of the results from a sodium-water reaction that occurred in a steam generator in the Enrico Fermi Plant revealed a generalized corrosion in the area of the reaction, producing failure of some of the adjacent tubes. The questions raised by this experience clearly indicated that the problem of small leaks causing general tube wastage should be investigated. An experimental program was designed to establish the mechanisms of wastage, including wasted surface temperature measurements, chemical attack, and hot erosion, and to establish the effect of design and operating parameters on wastage occurring in a test rig that stimulates the dynamics of a commercial steam generator. A small test rig supporting a 4-ft-high reaction vessel containing 5 gal of sodium was constructed. Wasted surface temperatures measured in this rig using thermocouples as the target for the sodium-water reaction have indicated temperatures in excess of 2200°F. Corrosion studies, using the reaction products NaOH and Na_2O, have shown severe attack on $2\frac{1}{4}$ Cr-1 Mo steel tabs in 1 hr under an argon atmosphere at 2200 to 2400°F. Evidence indicates that corrosion is minimal in the gas space above the reaction products, extremely severe at the gas-liquid interface, and less severe in the molten reaction products. A 101-ft-high support structure was constructed to house a test rig designed to stimulate the conditions in a commercial sodium-heated steam generator. The test rig circulates 5700 lb of sodium at 400 gal/min through a 16-ft-high reaction vessel. Tests conducted in this rig have shown that the circulating water coil, which served as the target tube during the sodium-water reaction, was wasted to the point of rupturing, causing a large secondary reaction and additional damage to surrounding material. The temperature recorder went off scale at 2200°F, indicating higher temperatures. In addition, large quantities of hydrogen, resulting from the reaction, were vented to the atmosphere without incident through a 2-in. pipe and an oil-filled reaction products trap. (auth)

12971 EXPERIENCE IN THE DESIGN AND OPERATION OF HIGH-TEMPERATURE ALKALI METAL SYSTEMS. Werner, R. C.; Andrews, R. C. (MSA Research Corp., Evans City, Pa.). pp 343-66 of Alkali Metal Coolants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria. See STI/PUB-143; CONF-661110.

Operation (up to 1200°F) of two sodium systems to study the instream mechanical properties of materials for long periods of time reveals the satisfactory operation of many components and the trouble to be experienced when operation is attempted with impurities added to the sodium. Cold-trap purification of 1200°F sodium systems is sufficient for low-corrosion operation over a 2-yr period in an AISI, type 316 stainless-steel system. Adding new specimens always raises the oxygen level, requiring repurification of the sodium. Carbon was removed by the cold trap when high carbon-sodium conditions prevailed, but removal is not complete enough for satisfactory operation; therefore great care should be taken in preventing the carbon contamination. Plugging indicators were a good tool for normal operation. Under high carbon conditions the initial break in the plugging indicator curve can be related to the carburization potential of the sodium. Inert gas lines in sodium systems need to be heated above the melting point of sodium to prevent plugging. However, under high oxygen-sodium conditions, solids deposit in the cover gas-regions under ambient temperatures above the melting point of sodium. It is observed that the main difficulty incurred in running with high oxygen-sodium systems in the oxide plugging of small lines. In high carbon sodium systems, the failure of valve bellows by carburization causes operational difficulties. Stability of magnetic flowmeters and reliability of electromagnetic pumps for long-term operation in sodium loops are discussed. In general, these components give excellent performance. (auth)

12972 COMPATIBILITY OF DIFFERENT BRAZING ALLOYS DURING LONG TIME-EXPOSURE IN SODIUM LOOP. Soenen, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.).

pp 391-414 of Alkali Metal Coolants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria. See STI/PUB-143; CONF-661110.

The design and instrumentation of loops used in solution of particular problems connected with in-pile capsules and loops are described. Results of test are analyzed for a loop containing an expansion bellows with interior guide, and guided and unguided passages of differently mounted types of coaxial wires with different types of brazing alloys. Semi-automatic induction brazing is applied on all passages while development work is carried on to arrive at a complete automatic brazing technique. It is intended, during a long time-exposure test, to examine the behavior of the bellows and, for each passage, the effects of having guided and unguided stainless-steel bushes with some wires mounted to pass through the tube and others to protrude into the tube. Descriptions of the loop, tests done with the loop to verify operating characteristics and security measures, are given and testing sequences, and the operation of the loop with the test section installed, together with the test results and their interpretation are summarized. The five brazing alloys elected for testing performed well at 450 to 600°C and 1 to 0.65 liters/s sodium flow during a 7000 hr run. After this period the brazing alloys did not fail for long peak temperatures up to 700°C. Metallographical examination of the brazing alloys is given to compare compositional and structural changes with the existing blanks. (auth)

12973 PRECIPITATION OF OXIDES FROM A SODIUM STREAM. Subbotin, V. I.; Kozlov, F. A. (Inst. of Physics and Power Engineering, Obninsk, USSR). pp 535-51 of Alkali Metal Coolants. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria. See STI/PUB-143; CONF-661110.

In work on the design of cold traps for sodium oxides, it is important to know how the oxides are distributed throughout the trap and the relationship between this distribution and various factors. By a physical and mathematical analysis the basic parameters governing the mass-transfer processes are determined as well as the nature of the functional dependence of changes in the supersaturation of the solution and thus in the oxide stream on the mass-transfer surface along a cold-trap model, in a case where dt/dx = const. and $dt/dx = 0$. The results of an experimental study of oxide precipitation in a cold-trap model are presented, with and without a temperature gradient, and the results obtained with the help of analytical relationships developed in the course of mass transfer investigations are discussed. It is suggested that the low capacity of the trap is attributable to local clogging of its flow-passage cross-sectional area, and methods are recommended for ensuring more even spreading of the precipitated oxides throughout the trap. (auth)

12974 IMPURITIES IN THE PRIMARY SODIUM AND COVER GAS OF THE ENRICO FERMI ATOMIC POWER PLANT. Lagowski, J. P. (Atomic Power Development Associates, Inc., Detroit); Havlena, E. pp 567-82 of Alkali Metal Coolants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria. See STI/PUB-143; CONF-661110.

The primary sodium and argon cover gas of the Fermi reactor have been monitored for impurities. Periodic sodium samples are analyzed for carbon, hydrogen, oxygen, iron, and recently for nickel and chromium. A chromatograph is used to monitor the cover gas for hydrogen, oxygen, nitrogen, methane, and carbon monoxide. A typical sodium analysis shows 50 ppM total carbon, 2 ppM carbon as sodium carbonate, 1 ppM total hydrogen, 10 ppM oxygen and 2 ppM iron, Hydrogen, oxygen, methane, and carbon monoxide are routinely less than 10 ppM in the cover gas, with nitrogen in the 3000-ppM range. Higher peak values have been experienced, which are dependent in some cases upon plant operating conditions such as primary system temperature and cover gas system operations. Cold-trap operation has routinely kept oxygen in sodium down to the 10-ppM range, with results obtained as low as 7 ppM. Hydrogen in sodium has been kept in the 1-ppM range using the cold trap. Examination of the first Fermi cold trap shows evidence of removal of nitrogen. The source of hydrogen in the sodium is believed to be the graphite in the top shield graphite. Several possible sources of the nitrogen in the cover gas have been identified. One, diffusion of nitrogen into the primary system, is of possible significance to sodium-cooled reactors operating in the 900 to 1200°F range. (auth)

12975 EXPERIENCE IN INVESTIGATION OF COMPONENTS OF ALKALI-METAL-VAPOR SPACE POWER SYSTEMS. English, R. E.; Weltmann, Ruth N. (Lewis Research Center, Cleveland). pp 711-25 of Alkali Metal Coolants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria. See STI/PUB-143; CONF-661110.

As a preliminary to development of a reactor powered alkali metal vapor turbogenerator power system for use in space, components of such a system have been studied and operated in various alkali metal loops. The observed performance of the components and the experience in operation of the loops are both described. Heat transfer to boiling potassium was investigated in a 300 kW loop of L-605 for temperatures as high as 1750°F, and in a 150 kW loop of Nb-1Zr for temperatures as high as 2100°F. In addition, heat transfer to boiling sodium was investigated in a 500 kW bimetallic loop of Nb-1Zr and 316 stainless steel; the boiling temperature reached 2000°F. Condensation of potassium at 1200 to 1500°F was investigated in two loops of 50 and 150 kW capacity. Wet potassium vapor at 1500°F was produced by a 3 MW gas-fired boiler and supplied to a 2-stage turbine; although the entire loop was built of 316 stainless steel, the turbine rotor blades were of TZC, TZM, and Udimet 700 so that erosion resistance could be compared. The condition of the turbine at the end of an endurance run of 500 hr is described. Alkali metals at 1100 and 1980°F were pumped for several thousand hours by, respectively, a motor-driven centrifugal pump designed for flight and an electromagnetic induction pump; the pump-designs are described. Both electrical and magnetic materials for long-time use at 1100°F have been investigated; results of these tests are presented. The methods used for measuring fluctuating pressure in these alkali metal systems are also described. (auth)

12976 MICROGRAPHIC STUDY OF THE BREAKAWAY PROCESS IN ZIRCONIUM OXIDATION. Keys, L. H.; Beranger, G.; De Gelas, B.; Lacombe, P. (Centre de Recherches Metallurgiques de l'Ecole des Mines de Paris, France). J. Less-Common Metals, 14: 181-200(Feb.1968). (In French).

The kinetics of the oxidation of zirconium in oxygen at elevated temperatures are characterized by the transition from a quasi-parabolic rate law to an apparently linear law for longer oxidation durations. Together with the occurrence of this kinetic transition, a continuous modification in the morphology of the oxide film leading to the break-away of the film is observed. A study of the structural changes of the oxide formed during the oxidation at 700° to 1050°C has been performed by metallography; the occurrence of fissuring in the oxide film and the separation of a white oxide film from the black, metal-adherent oxide is shown and discussed especially in connection with the relative mechanical properties of the oxide and of the metal substrate. The various experiments described have led to a suggested mechanism for the break-away phenomenon. (auth)

12977 OXIDATION OF RHENIUM AND A RHENIUM-8 PERCENT TITANIUM ALLOY IN FLOW ENVIRONMENTS AT OXYGEN PRESSURES OF 1 TO 10 TORR AND AT 800° TO 1400°C. Gulbransen, E. A.; Brassart, F. A. (Westinghouse Research Labs., Pittsburgh). Contract DA-31-124-ARO-D-196. J. Less-Common Metals, 14: 217-24(Feb. 1968).

The oxidation behavior of rhenium and a rhenium-8% titanium alloy have been studied under flow conditions at 800 to 1400°C and at oxygen pressures of 1 to 10 torr. The kinetic data below 1100°C indicated that the reaction was under a chemically controlled process such as mobile adsorption. A closer analysis of the pressure dependence suggested that additional factors affect the rates of oxidation in addition to an adsorption process. At about 1100°C, a transition occurs to a gaseous diffusion-controlled rate process. (auth)

12978 ADAPTATION OF LINEAR POLARIZATION TECHNIQUES FOR IN-SITU CORROSION MEASUREMENTS IN WATER COOLED NUCLEAR REACTOR ENVIRONMENTS. Wilde, B. E. (General Electric Co., Pleasanton, Calif.). Corrosion, 23: 379-84(Dec. 1967).

Application of electrochemical polarization techniques to study corrosion of steels in aqueous environments at 289°C and 1000 psi is described. A galvanostatic polarization circuit is discussed which permits determination of polarization parameters in situ which are free of error due to resistance polarization in high purity water. Extended corrosion tests on plain carbon steel and Type 304 steel over 500 hours have shown that 99.6 percent correspondence can be achieved between electrochemical corrosion data and conventional weight-change techniques. In de-oxygenated conditions, the steady-state corrosion rates of plain carbon steel and Type 304 stainless steel are 0.0015 and 0.0011 $mg/cm^2/hr$, respectively in water at 289°C. Cathodic and anodic Tafel constants for these steels have been determined and are shown to be independent of exposure time and corrosion rate. (auth)

12979 CORROSION OF PREFILMED ZIRCALOY. Kass, Stanley (Bettis Atomic Power Lab., West Mifflin, Pa.). Corrosion, 23: 374-8(Dec. 1967).

Experiments have been performed to explain the memory phenomenon observed when Zircaloy specimens are corroded at a lower temperature after a period of exposure at a higher temperature. With pre-transition films, corrosion proceeds as if prior exposure had been at the lower temperature. The new rate with thick, post transition films formed at 400°C and higher, follows that of the unfilmed metal. If the prior exposure was at 360°C or lower, the new rate may follow that of unfilmed metal or may proceed as if the initial exposure was at the lower temperature. The behavior is believed to be dependent upon the presence or absence of cracks in the oxide. (auth)

12980 THERMODYNAMICS OF THE TUNGSTEN–OXYGEN SYSTEM. Rizzo, F. E.; Bidwell, L. R.; Frank, D. F. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Trans. Met. Soc. AIME, 239: 1901-5(Dec. 1967).

The solid electrolyte galvanic cell technique was used to measure the ΔG^0 of various reactions of the W–O system at 700 to 1000°C. The results may be represented by the following linear equations: $\frac{1}{2}W + \frac{1}{2}O_2 \rightleftharpoons \frac{1}{2}WO_2$, $\Delta G^0_I = -68{,}660 + 20.31\ T(°K) \pm 300$ cal; $\frac{1}{0.72}WO_2 + \frac{1}{2}O_2 \rightleftharpoons \frac{1}{0.72}WO_{2.72}$, $\Delta G^0_{II} = -59.640 + 15.01\ T(°K) \pm 300$ cal; $\frac{1}{0.18}WO_{2.72} + \frac{1}{2}O_2 \rightleftharpoons \frac{1}{0.18}WO_{2.90}$, $\Delta G^0_{III} = -67.860 + 24.21\ T(°K) \pm 300$ cal; $\frac{1}{0.10}WO_{2.90} + \frac{1}{2}O_2 \rightleftharpoons \frac{1}{0.10}WO_3$, $\Delta G^0_{IV} = -66.765 + 26.76\ T(°K) \pm 500$ cal. The measured free-energy changes varied slightly with purity. These results differ significantly from earlier electromotive-force measurements. Excellent agreement was obtained with recent gas equilibration measurements. The results do not support the presence of W_3O. (auth)

12981 INFLUENCE OF INDUCED RADIOACTIVITY OF STEEL 45 ON THE PROTECTIVE PROPERTIES OF CERTAIN INHIBITORS DURING THE DISSOLUTION OF STEEL IN SULFURIC ACID. Balezin, S. A.; Laptev, N. Ya.; Spitsyn, V. I. Zashch. Metal., 3: 742-4(Nov.-Dec. 1967). (In Russian).

The effect of the induced radioactivity of steel 45 on the protective properties of inhibitors of the cation, anion, and molecular type in H_2SO_4 was investigated. It was established that the rate of dissolution of the radioactive samples in acid solutions containing "Catapin A," Ca iodide, and formaldehyde in concentrations giving the greatest protective effect is in all cases higher than the nonradioactive samples. In cases of inhibitors of the cation type this effect is connected with the accumulation of positive charges, because of β irradiation, in the surface film on the radioactive metal. (tr-auth)

12982 MATERIALS FOR SMALL RADIUS LEADING EDGES FOR HYPERSONIC VEHICLES. Hill, Maynard L. (Johns Hopkins Univ., Silver Spring, Md.). J. Spacecraft Rockets, 5: 55-61(Jan. 1968).

Symmetrical wedge models of sharp leading edges were fabricated from candidate refractory materials and tested in a 10-MW-arc-heated, freejet facility producing nominal plenum conditions of 380 psia and 5500°F. Experiments were first conducted with specially developed temperature probes to determine heat-transfer coefficients and recovery temperature at various stations in the freejet. Tests of the models were then carried out at appropriate stations in the freejet to produce tip temperatures at 3200 to 3900°F to simulate temperatures such as would be encountered in flight at velocities up to 7800 fps at altitudes near 70,000 ft. Successful performance was obtained with several models having 0.03-in. or smaller radii with little or no erosion occurring during runs of 13 sec duration. The best results were obtained with solid models of a ductile metallic alloy of hafnium-20% tantalum and with coatings of this alloy on a graphite or tantalum-10% tungsten alloy substrate. Several brittle materials, such as metallic carbides and boron nitride, showed good erosion resistance, but fracture was frequently encountered due to the unusually severe thermal shock associated with the test. The results indicate that the materials may be serviceable at similar velocities and altitudes near sea level. (auth)

12983 BEHAVIOUR OF CARBON DURING THE CORROSION OF STAINLESS STEEL BY CARBON DIOXIDE. Antill, J. E.; Warburton, J. B. (Atomic Energy Research Establishment, Harwell, Eng.). Corros. Sci., 7: 645-9(Sept. 1967).

Published information is summarized on the behavior of carbon during the corrosion of austenitic stainless steel in CO_2 and CO_2–CO atmospheres at 650 to 900°C. A general pattern of behavior has emerged, and has been extended by recently obtained unpublished results on a 20% Cr 25% Ni steel stabilized with niobium. (auth) (UK)

12984 CORROSION PROTECTION FOR PRESTRESSING TENDONS. Nucl. Eng., 12: 775(Oct. 1967).

The method of protecting the bottom cap cables of the Wylfa reactor concrete pressure vessel, designed to be fully effective for 30 years, consists of filling the metal ducts with a hydrocarbon compound containing a volatile corrosion inhibitor. The material, which is molten at 65°C, is pumped into the ducts. It is slump resistant at 50°C, and will reach a temperature of 30 to 40°C in operation. (UK)

12985 EROSION OF THE REFRACTORY ZIRCONIUM OXIDE CERAMICS. 3. INFLUENCE OF THE POTASSIUM ADMIXTURE ON THE EROSION STABILITY OF SUBSTANCE IN THE BURNING PRODUCT STREAM. Abraitis, R. (Inst. of Physical-Technical Problems in Power Engineering, Vil'nyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B, 3: 115-20 (1967). (In Russian).

Equipment for the introduction of the ionizing potassium admixture into high-temperature burning product stream is described. The equipment allows introduction of the admixture in the form of solution into the stream by means of burning as well as non-burning liquids. The method for the introduction of admixture without altering the stream speed and temperature on the wall of the sample under investigation was worked out. Investigation results obtained when introducing the admixture into the stream of burning products and investigating the stability of the zirconium oxide under already mentioned conditions are given (temperature of stream — 2320°K, stream speed 500 m/sec). Results are compared with the data previously described. It is shown that the admixture ionizing the stream increases the erosion speed about 10 to 27% in comparison with the speed of erosion in the non-ionized stream. (tr-auth)

Preparation and Fabrication

Refer also to abstracts 12493, 12498, and 14314.

12986 (RFP–1065) PHASE DISTRIBUTION OF PLUTONIUM AND AMERICIUM IN PRODUCTION ELECTROREFINING. Brown, James C. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Jan. 9, 1968. Contract AT(29-1)-1106. 5p. Dep. CFSTI.

Plutonium can be purified by a nonaqueous, electrorefining technique. In such a process, most of the plutonium is recovered as pure metal at the cathode, while some remains as an impure anode and some remains in the molten-salt electrolyte. Americium-241, an impurity contained in the original feed plutonium, has high radioactivity. Thus, the removal and concentration of americium pose certain problems. To investigate the distribution of plutonium and americium in sodium, potassium, and magnesium chloride salts; in product metal; and in anode; some 31 electrorefining runs were made. The final results are summarized. Briefly, findings show after electrorefining that the average americium content of the feed metal was 960 parts per million (ppM) and of the salt, 1230 ppM. The average americium concentration in the product metal was 267 ppM. An average of 35.2 grams of plutonium per run was found in the salts as plutonium chloride. In runs where feed anodes depleted to less than 200 grams, impurities other than americium were found in the salts. After electrorefining, an average of 362 grams of plutonium was retained in the salts also as metal globules. (auth)

12987 (RMI–9) SEMIANNUAL PROGRESS SUMMARY [ON URANIUM FABRICATION], JANUARY–JUNE 1967. (Reactive Metals, Inc., Ashtabula, Ohio). Oct. 27, 1967. Contract AT(30-1)-1405. 57p. Dep. CFSTI.

Three projects on uranium fabrication by precision extrusion were conducted. In the first, the feasibility of extruding NPR ingots directly to final secondary billet size was investigated by analyzing the dimensional results of an NPR type extrusion. It was concluded that precision extrusion of this material should be feasible as a production operation. Second, work was directed toward the conversion of precision extrusion to an efficient production process. The techniques for precision extrusion of Mark VR Inner fuel cores were developed and the dimensional control possible was established. In the case of the Mark VR Outer size, only a slight as-extruded ovality problem remains to be solved. Third, the effect of the beta heat treatment on the final fuel core dimensions was studied to determine the magnitude of this size change, and methods to predict and control this were developed. Smaller projects of a plant assistance nature, designed to bring about more efficient and economical operation of the plant in the extrusion of production material, were also undertaken and are continuing. (L.C.L.)

12988 EVIDENCE FOR VOIDS IN ANNEALED DOPED TUNGSTEN. Koo, Ronald C. (Westinghouse Electric Corp., Bloomfield, N. J.). Trans. Met. Soc. AIME, 239: 1996-7(Dec. 1967).

Evidence is presented that areas of light contrast observed in transmission electron microscopy of rolled and annealed doped W are not fine particles of mullite ($Al_6Si_2O_{13}$) but are voids. It is pointed out that the "voids" are absent in unannealed specimens and appear only after annealing and that precipitation would require more aluminum than is actually present. The observed variation in light contrast is in agreement with the theory of diffraction contrast formation from small voids. Extraction of particles from doped W ribbon by carbon replication has failed to show particles aligned in rows. (A.G.W.)

12989 GRAIN BOUNDARY PRECIPITATION IN SHEET ROLLED FROM BERYLLIUM INGOTS. Fraikor, F. J.; Grotzky, V. K. (Dow Chemical Co., Golden, Colo.). Trans. Met. Soc. AIME, 239: 2008-10(Dec. 1967).

The effects of various heat treatments on grain boundary precipitation in commercial-purity Be sheets were observed by transmission electron microscopy. Analysis of precipitates in specimens quenched from 1200°C into brine at −7°C showed evidence of Al but no iron. In furnace-cooled (~5°C/min in Ar) specimens, the precipitates were of the type termed $Be_5(Fe,Al)$ or $AlFeBe_4$. The precipitates that appeared throughout the matrix after aging quenched specimens at 780°C were identified by electron diffraction as platelets of hcp $Be_{11}Fe$. On subsequent reheating of these specimens the matrix precipitates disappeared, but a few grain boundary precipitates, presumably free Al, remained. (A.G.W.)

12990 PURIFICATION OF IRON AND ZIRCONIUM BY ZONE TRANSFORMATION. Ailloud, P.; Langeron, J. P. (Centre d'Etudes de Chimie Metallurgique, Vitry/Seine, France). J. Nucl. Mater., 25: 69-74(1968). (In French).

By displacing very slowly a γ-phase zone along a bar of α iron and a β-phase zone along a bar of α zirconium, impurity segregation was observed in accordance with the equilibrium diagrams. The apparatus was used with an ultra high vacuum. The zone-length was maintained constant by regulating the furnace temperature. In the case of iron, the effective partition coefficients after treatment were calculated according to Millikan's formula. The coefficients indicated that the process is feasible, but because of unfavorable diffusion in the γ phase, the method is unlikely to be widely favored. In the case of zirconium, measurements of hardness and of low temperature resistivity demonstrated pronounced segregation of oxygen and nitrogen. Systematic use of the technique is a possibility. (auth)

12991 WELDING AND BRAZING OF HIGH TEMPERATURE RADIATORS AND HEAT EXCHANGERS. Slaughter, G. M. (Oak Ridge National Lab., Tenn.); Franco-Ferreira, E. A.; Patriarca, P. Weld. J. (N. Y.), 47: 15-22(Jan. 1968). (ORNL-P-3269).

Procedures were developed for fabricating high-performance radiators and heat exchangers for nuclear and space applications. These components contain multitudes of complex tube-to-tube sheet and tube-to-fin joints. To ensure reliability of the tube-to-tube sheet joints, techniques producing welds of extremely high quality were used and back-brazing of the welds with a suitable alloy was incorporated. High-temperature brazing was also incorporated to reliably attach high-conductivity fins to stainless steel and Inconel tubes in the radiators. The selection of a suitable brazing alloy for these applications was dependent upon several factors, including corrosion and oxidation resistance, flow point, and mechanical properties. Nickel-silicon-boron and nickel-chromium-phosphorus alloys were found to be adequate from these considerations. Special brazing procedures were developed to obtain satisfactory flowability of tube-to-fin joints. The suitability of these procedures was demonstrated by the successful construction of large full-size units for performance tests. (auth)

12992 OXY-CUTTING MACHINE FOR WYLFA LINERS. Nucl. Eng., 12: 774(Oct. 1967).

The precision machine used for cutting the ¾ in. steel plate liners for the concrete pressure vessels of the reactor is described and illustrated. The 400 penetrations (18 to 19 in. dia) were cut in situ in the 96 ft dia upper hemisphere. (UK)

12993 CATALYTIC GRAPHITIZATION OF CARBON BY TITANIUM. Schwartz, A. S.; Bokros, J. C. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(29-2)-1809. Carbon 5: 325-30(Sept. 1967).

It was shown that the graphitization of carbons deposited in fluidized beds can be catalyzed by titanium. The data indicate that at temperatures near 1200°C titanium and carbon can be co-deposited and then annealed at 2200°C for 4 hr to convert the carbon to graphite; and at temperatures >2000°C the catalysis by titanium occurs during deposition when the deposition rates are low; when the deposition rates are high, the carbon co-deposited with titanium can be converted to graphite in a subsequent 4-hr anneal at 2200°C. A minimum of 5 to 7 wt % titanium is necessary to cause the catalysis when the procedures outlined above are followed. (auth)

12994 METHOD OF FABRICATING ZIRCONIUM–BERYLLIUM EUTECTIC WIRE. Quinlan, Frank B. (to United States Atomic Energy Commission). U. S. Patent 3,363,304. Jan. 16, 1968.

The production of wire from the exceedingly brittle zirconium–beryllium eutectic, which is used in the brazing of Zircaloy is described. A rod of the alloy is encased in a heavy stainless steel capsule and swaged at specific temperatures in the 700 to 800°C range until greatly elongated. The stainless steel is then dissolved in sulfuric acid. A ½ inch Zr–Be rod has been reduced to a .025 inch wire by this method. (AEC)

12995 IMPROVEMENTS IN SEALED HIGH TEMPERATURE JOINTS BETWEEN A MATERIAL WITH A MAGNESIUM BASE AND ANOTHER METAL. Crouzet, Elie; Vere, Bernard (to Commissariat a l'Energie Atomique). British Patent 1,099,025. Jan. 10, 1968. Priority date Mar. 16, 1964, France.

A method for producing a sealed high temperature joint between Mg or Mg alloy and Zircaloy, Ni, stainless steel, or Inconel is described. The joints are used for obtaining a sealed passage for thermocouples through the sheaths or cans of fuel elements used in reactors. The joints are made by a welding operation by an arc in a neutral atmosphere such as argon. The filling metal is Mg–Zr wire. (F.S.)

12996 PRODUCTION OF LOW PARTICLE SIZE-HIGH SURFACE AREA METAL POWDERS. (to United States Atomic Energy Commission). British Patent 1,098,246. Jan. 10, 1968. Priority date July 6, 1964, United States.

A process is described for production of irregular shaped, extremely pure, micron and submicron size metal powders having an unusually high surface area. Gas streams of a volatile metal fluoride of the metal in either H or F carrier gas, and a nonselected carrier gas are introduced into a nozzle and surrounding annulus nozzle. The H and F are reacted to form an H–F flame. The metal powder issuing from the flame is collected. (F.S.)

12997 OBRABOTKA DAVLENIEM TUGOPLAVKIKH METALLOV I SPLAVOV. (Pressure Treatment of Refractory Metals and Alloys). Korneev, N. I.; Pevzner, S. B.; Razuvaev, E. I.; Skugarev, I. G. Moscow, Izdatel'stvo Metallurgiya, 1967. 267p.

Technology of pressure treatment of high melting metals (Mo, Nb, Cr, W, Ta, and their alloys) is discussed and production methods of various semi-finished products by extrusion, forging, punching, rolling, and drawing are described and analyzed. (218 references are included). (R.V.J.)

12998 PRODUCTION OF SPHEROIDAL URANIUM METAL POWDER. Trent, P. E. (to United States Atomic Energy Commission). U. S. Patent 3,369,889. Feb. 20, 1968.

The production of spheroidal uranium metal powder in a size range of −44 to +840 microns by the exothermic reaction of UO_2 with calcium metal reductant and iodine booster is described. Particulate uranium metal is incorporated in the reaction mixture in a uranium metal-to-UO_2 ratio of about 9 to 10 by weight to control the particle size of the spheroidal product to assure that about 85 per cent of the latter is of a size greater than 44 microns with the largest single fraction of the product being in a size range of 149 to 420 microns. (auth)

Properties Evaluations

Refer also to abstracts 12270, 13569, 13596, and 13597.

12999 (BNWL-473, pp 9.1-18) METALLIC FUELS. Last, G. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The successful irradiation of three Th–2.5 wt % U–1.0 wt % Zr tubular fuel elements continued in the P-7 pressurized water loop in the ETR. Swelling calculations based on measurements taken on the three elements in air in a hot cell agreed closely with values determined from weighing the fuel elements in water. Thirty-four hollow core uranium fuel elements 0.45 in. dia by 6.25 in. long and coextrusion clad with Zr-2 have been successfully irradiated in the ETR-M-3 loop facility. Five elements have single throw warp in the range from 0.025 to 0.050 in. The remaining rods have less than 0.025 in. single throw warp. Neutron radiographs obtained on two elements of which the volume decrease has stopped and reversed, show that the central void or hole has not significantly decreased in diameter and therefore that collapse or closure of the central hole is not the cause of the reversal of volume decrease. The neutron radiographs also reveal transverse cracks in the uranium fuel at two successive

irradiation exposures. A successful extrusion experiment demonstrated the feasibility of directly coextruding 0.600 in. dia Zircaloy-2 clad uranium rods with central voids as small as $\frac{1}{8}$ in. Thin wall (0.100 in.) thorium alloy fuel tubes clad with Zircaloy-2 on the OD and ID were successfully extruded. (J.C.W.)

13000 (CEA-R-3253) DIFFUSION DE L'URANIUM EN DILUTION INFINIE DANS LE TITANE β ET LE FER γ. (Diffusion of Extremely Dilute Concentrations of Uranium in β-Titanium and γ-Iron). de Keroulas, Francois (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). July 1967. 52p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, Orsay, France.

A method based on the recording of fission fragments in insulators, allowing the study of uranium concentrations in metals about 10^4 to 10^5 lower than those possible by autoradiography of ^{235}U is described. This method has been used to study the diffusion of uranium concentration between 10^{-7} and 10^{-8}) in β titanium and in γ iron. The diffusion coefficient obey the equation: $D = D_0 \exp(-H/kT)$ with $D_0 = 2.10^{-3}$ cm^2 s^{-1} and H = 1.43 eV/at. for titanium and $D_0 = 7.10^{-5}$ cm^2 s^{-1} and H = 1.38 eV/at. for iron. In titanium there is a distinct increment of diffusion when the allotropic transformation is reached; it appears to be due to the point defects created by the transformation. (auth)

13001 (CONF-661216-2) PROPRIETES MAGNETIQUES DE COMPOSES DEFINIS ENTRE COBALT ET METAUX DE TERRES RARES. (Magnetic Properties of Definite Compounds of Cobalt and the Rare Earth Metals). Lemaire, R.; Schweizer, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1966]. 22p. (In French). (N.I.-66/4).

From Conference on the Study of Structures by the Use of Neutrons, Moscow, USSR.

The magnetic properties of the compounds TCo_5, TCo_3, and TCo_2 where T represents Y, Ce, Nd, Sm, Gd, Tb, Dy, Ho, Er, and Tm were studied. TCo_5 is isomorphic with $CaCu_5$; TCo_3 is isomorphic with $PuNi_3$; and TCo_2 is isomorphic with $MgCu_2$. (J.S.R.)

13002 (CU-2660-37) THERMAL CONDUCTIVITY OF THE ALKALI METAL VAPORS AND ARGON. Lee, Chai-sung; Bonilla, Charles F. (Columbia Univ., New York. Liquid Metals Research Lab.). Nov. 14, 1967. Contract AT(30-1)-2660. 17p. (CONF-671110-3). Dep. CFSTI.

From 7th Conference on Thermal Conductivity, Gaithersburg, Md.

The frequency response to alternating current of a fine wire surrounded by alkali metal vapor was studied theoretically and experimentally for determining the thermal conductivity of the vapor. Data were obtained for cesium and rubidium vapors at 0.0829 to 0.214 atm. A new method was employed of correcting for temperature jump and vapor volumetric heat capacity. In addition, the thermal conductivity of the alkali metal vapors was calculated by gas kinetics theory, including the effects of dimerization and heat of association. Good agreement between experiment and theory was obtained considering the possible errors. The total probable experimental error is estimated at 6.1%, and the uncertainty in the theoretical analysis at about 25%. Reliability of the method is indicated by agreement with literature values for argon up to 1085°C. The standard error of the argon correlation is estimated at 1.6%. (auth)

13003 (ORO-2036-5) PROGRESS REPORT [ON DIFFUSION IN ALLOYS AND SALTS], DECEMBER 16, 1966-DECEMBER 15, 1967. Slifkin, Lawrence (North Carolina Univ., Chapel Hill). Dec. 1967. Contract AT(40-1)-2036. 9p. Dep. CFSTI.

SILVER ALLOYS & SYSTEMS—Ag-Au, diffusion couple annealing at 850°C; Ag-Cd, diffusion activation energies in alpha-phase; Ag-Al, diffusion of silver in
ALUMINUM—diffusion of silver in
ALUMINUM ALLOYS & SYSTEMS—Al-Zn, diffusion of silver in; Al-Cu, diffusion of silver in
GOLD IONS, ZINC IONS, ZINC ISOTOPES Zn-65, IODIDES, BROMIDES—diffusion in silver chloride
SILVER BROMIDES—diffusion of iodide ions in (D.L.C.)

13004 (BNL-tr-170) ON THE POSSIBLE PHYSICAL NATURE OF SPASMODIC DEFORMATIONS. Romashkin, Yu. P.; Shestopalov, L. M. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y., from Diffuz. Protsessy Metal., Dokl. Vses. Nauch. Konf., Kiev, 1964, 101-6(1966). 8p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The physical nature of spasmodic behavior of deformation was studied. The diffusion rate was found to be a complex function of the deformation parameters depending on the diffusion coefficients of the deformed and undeformed metal, stress, mean diffusion rate, lifetime of the defects arising in the presence of deformation the activation energy of motion of the defect, and the time of the experiment. It was found that deformation occurs in limited temperature intervals and deformation rates. (F.S.)

13005 (UCRL-Trans-10180) PROCESS FOR INCREASING THE PERMEABILITY OF METALS TOWARD HYDROGEN. Kussner, Albrecht; Wicks, Ewald. Translated by D. McCallum for Univ. of California Lawrence Radiation Lab., Livermore, from German Patent 1,154,443. 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

A process is described for increasing the H permeability of Pd, Pd alloys, Ta, Ti, and U. The metals are brought into contact with UH or TiH or are coated with these hydrides. The process is used in the purification of H, separation of H isotopes, or to produce H electrodes. (F.S.)

13006 A FIELD-ION MICROSCOPY STUDY OF A TUNGSTEN-3 AT PERCENT RHENIUM ALLOY: STREAK CONTRAST EFFECTS. Soffa, W. A.; Moazed, K. L. (Ohio State Univ., Columbus). J. Less-Common Metals, 14: 211-16(Feb. 1968).

Field-ion microscope observations of a tungsten-3 at. % rhenium alloy were made to determine whether a definite correlation between image streaking and some metallurgical condition of this alloy could be established. Streak contrast effects were observed but no such correlation was found. It is suggested here that the primary cause of streaking is associated with tip asymmetry produced during specimen preparation rather than with intrinsic features such as stacking faults. The possible role of alloying element and impurity segregation is cited. (auth)

13007 THE INFLUENCE OF HEAT TREATMENT ON THE TENSILE BEHAVIOUR OF URANIUM IN THE TEMPERATURE RANGE 20 TO 200°C. Beevers, C. J.; Newman, G. T. (Univ. of Birmingham, Eng. Oak Ridge National Lab., Tenn.). J. Less-Common Metals, 14: 225-30(Feb. 1968).

Reactor-grade uranium in the form of wire tensile specimens has been tested at 20 to 200°C. Specimens quenched from the β-phase exhibited serrated yielding at 100°C and above and at strain rates of 2.6×10^{-4} sec^{-1}. Specimens β-annealed and furnace cooled and β-quenched and α-annealed showed no evidence of serrated yielding. The tensile results obtained from the β-quenched and β-quenched/α-annealed specimens show that β-quenching can result in a ductility minimum at 150°C. (auth)

13008 CAUSES OF LONGITUDINAL SPLITTING OF TUNGSTEN WIRES. Jesionek, Boleslaw; Kostkowski, Andrzej; Stolarz, Stanislaw. Rudy Metale Niezeladz., 12: 571-4(Nov. 1967). (In Polish).

The effects of certain processing variables on the longitudinal splitting of tungsten wires were investigated. Splittings of thick rods and wires were evaluated by comparing indications of the Foster induction defectoscope and splittings of thin wires by comparing measurements of the modulus of rigidity. It was proved that split wires have a reduced modulus of rigidity of over 2500 kg/mm^2. (auth)

13009 DIFFUSION OF METALLIC IMPURITIES INTO ZIRCONIUM AND TITANIUM. Pavlinov, L. V. Fiz. Metal. Metalloved., 24: 272-7(Aug. 1967). (In Russian).

Heterodiffusion parameters of metallic impurities (W, Mo, Cr, and Fe) in body-centered zironium phases and (W, Mo, Zr) in titanium were studied. Diffusion coefficients were determined by the method of integral residue (Mo, Zr, Fe, Cr) and absorption method using radioactive isotopes ^{185}W, ^{99}Mo, ^{95}Zr, ^{59}Fe and ^{51}Cr. Results obtained were analyzed considering anomalous diffusion processes in metals with polymorphic transformations and regularities of metallic impurity heterodiffusions. (R.V.J.)

13010 STUDY OF LITHIUM MOBILITY IN IRRADIATED SILICON. Hackler, Walter A. (Philco Corp., Newport Beach, Calif.); Kikuchi, Chihiro. Nucl. Sci. Eng., 31: 175-82(1968).

The effects of fast-neutron and electron-induced defects on the diffusion properties of lithium in silicon have been studied. Lithium-diffused diodes were irradiated and later drifted with reverse bias at a constant temperature. Results show that fast-neutron and 0.9-MeV electron induced vacancies provide sites for the precipitation of lithium. Moreover, the lithium vacancy precipitate behaves like a solute in equilibrium with ions and ionized vacancies. The analysis of the lithium vacancy precipitate in this manner is analogous to the analysis of slightly soluble salts in water. The lithium diffusion coefficient for silicon exposed to fast neutrons, $N_N = 1.1$ to 2.7×10^{14} n/cm^2, can be expressed $D = (7.0 \times 10^{12}/N_N) \exp(-0.83/kT)$ cm^2/sec. The range of (T) in the above expression is from 300 to 410°K. In addition, the lithium diffusion coefficient for silicon exposed to 0.9-MeV electrons, $N_E = 5 \times 10^{15}$ to 3.3×10^{16} electrons/cm^2 can be represented by $D = (2.1 \times 10^{18}/N_E) \exp(-1.03/kT)$ cm^2/sec. The range of (T) in the

above expression is from 300 to 330°K. Relative radiation damage between neutron and electrons was found to be in reasonable agreement with predictions based on radiation damage theory. (auth)

13011 DISSOCIATION ENERGY OF GASEOUS UAu. Gingerich, Karl A. (Battelle Memorial Inst., Columbus, Ohio); Blue, Gary D. J. Chem. Phys., 47: 5447-9(Dec. 15, 1967).

Results concerning the dissociation energy of the molecule UAu are reported. A sealed tungsten cell that contained a residue of uranium from a previous thermal decomposition of uranium mononitride was used. To this cell gold was added in one series and both gold and silver were added in another. The silver served for calibration purposes. The dissociation energy of the UAu molecule was obtained by measuring the enthalpy of reaction ΔH°_{0} for the chemical reactions $UAu(g) + Au(g) = Au_2(g) + U(g)$ and $UAu(g) = U(g) + Au(g)$. The dissociation energies, D°_{0} (UAu), derived from the measurements are presented in tabular form. Giving more weight to the values obtained from the pressure-independent reaction a dissociation energy D°_{0}, of 75 kcal/mole was obtained with an estimated accuracy of ±7 kcal/mole. The UAu molecule and gaseous AlAu, the dissociation energy of which is 77 kcal/mole, have the highest bond energies known for diatomic molecules between metal atoms. (D.H.M.)

13012 MAGNETIC PROPERTIES OF HARD SUPERCONDUCTORS. Prekul, A. F. (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved., 24: 260-7(Aug. 1967). (In Russian).

The magnetic properties of 0.25 mm wire specimens of the ternary alloy 58% Nb, 31% Ti, 11% Zr are investigated in a superconducting solenoid at 4.2°K. If the geometric factor is precluded, magnetic properties are determined only by the current-carrying capacity of the specimen, which is introduced in the calculations in the form of a characteristic quantity of the magnetic field $H^* = H^*(j_c)$. On specifying different values of H^* a family of magnetization curves may be obtained, with each curve corresponding to a specimen with a specific critical current density j_c. The findings show that an increase in j_c entails an increase in the area under the magnetization curve and in the remanent moment, i.e., the hysteresis increases. It is shown that H^* is indeed a characteristic quantity determining a stage in the penetration of the specimen by the magnetic field and representing the maximum possible local value of induction of a specimen in zero magnetic field; the family of curves shown in the figure makes it possible to trace the transition from a strongly inhomogeneous state to an ideal state; thus there exists a region of ideal diamagnetic behavior which is determined by the magnetic properties of the homogeneous superconductor of the second kind. A formula for determining the intensity of the magnetic field at which the magnetic flux penetrates to the center of the specimen is derived and on this basis models are analyzed. Thus it is shown that the magnetization curves of rigid superconductors display characteristic points which can be used as criterions for isolating individual stages in penetration by the magnetic field. (ATD)

13013 NITRIDING EFFECTS ON THE PROPERTIES OF MOLYBDENUM. Lakhtin, Yu. M.; Kogan, Ya. D. (Moscow Inst. of Transportation). Metalloved. Term. Obrab. Metal., No. 1 24-9(Jan. 1968). (In Russian).

The nitriding of Mo surface improved the plastic resistance of the metal from 60 to 90% at 1000 to 1400°C. The optimum nitriding for 1 to 1.5 mm thick nitrogen-saturated Mo sheets was found at 900 to 1000°C. (R.V.J.)

13014 PRECIPITATION HARDENING OF Mo-BASE ALLOYS. Morgunova, N. N. Metalloved. Term. Obrab. Metal., No. 1, 21-4(Jan. 1968). (In Russian).

Data obtained for Mo alloys showed the maximum aging takes place in Mo–C–Zr, Mo–C–Ti and Mo–C–Hf after tempering at 1600°C. The highest heat resistance was observed in Mo–C–Zr alloy. (R.V.J.)

13015 SOLUBILITY LIMIT AND DIFFUSIVITY OF CARBON IN MOLYBDENUM. Rudman, P. S. (Vanderbilt Univ., Nashville). Contract AF33(615)-1714. Trans. Met. Soc. AIME, 239: 1949-54(Dec. 1967).

The solubility limit and the diffusivity of carbon in molybdenum have been obtained by diffusing carbon into molybdenum rods from a Mo + Mo_2C powder mixture. The solubility limit was taken as the long-time asymptotic limit of the rod composition. The diffusivity was obtained from fractionally saturated rods from the rate of change of the average composition. Compositions were determined by chemical analysis. The solubility limit obtained is $\ln c_s = 16.78 - 2.29 \times 10^4/T$, with c_s in ppM by weight and T in °K. Combining this result with the heat of formation of Mo_2C it is calculated that C (graphite) = C (in Mo), $\Delta H = 50.0$ kcal. The diffusivity obtained is D(sq cm per sec) = 3.4×10^{-2} exp (–41,000/RT). No significant difference between diffusivities in polycrystalline and single-crystal material was observed. (auth)

13016 FORMATION OF GUINIER–PRESTON ZONES IN Cu–Be ALLOYS. Wilkes, P. (Univ. of Manchester, Eng.). Acta Met., 16: 153-8(Feb. 1968).

The results of an electrical resistivity study of G.P. zone formation in copper–beryllium alloys from 3.3 to 12.6 at % are reported. The electrical resistivity during zone formation shows a characteristic peak. Quenching from a range of temperatures enabled the activation energy of vacancy formation to be determined and gave activation energies close to 1 eV. Aging at a range of temperatures enabled the activation energy for vacancy motion to be determined as 0.6–1.1 eV dependent upon composition. The significance of the data is discussed and tentative explanations are proposed for the observed activation energies. The data show a binding energy of ~0.2 eV and the significance of this is discussed. (auth)

13017 ON THE ROLE OF VACANCIES IN SOLUTE CLUSTERING IN QUENCHED AND AGED COPPER–BERYLLIUM ALLOYS. Wilkes, P.; Barrand, P. (Univ. of Manchester, Eng.). Acta Met., 16: 159-66(Feb. 1968).

Results of a dilatometric and x-ray investigation into pre-precipitation phenomena in copper–beryllium alloys are reported. A large and detectable contraction occurs during G.P. Zone formation and this was used to determine the kinetics of the process. The activation energy for vacancy formation was found to be close to 1 eV and that for vacancy motion to vary from 0.7 to 1.2 eV depending on composition. The origin of the large contraction is discussed in terms of a large super-saturation of vacancies. (auth)

13018 LOW TEMPERATURE DEFORMATION OF ELECTRON IRRADIATED ALUMINUM. Buck, O. (North American Aviation Science Center, Thousand Oaks, Calif.); Keefer, D.; Robinson, J.; sosin, A.; Wiedersich, H. Acta Met., 16: 195-205(Feb. 1968).

Increases in the yield stress of aluminum single crystals following 1 MeV electron irradiation at 20°K are consistent with a model of dislocation motion impeded by dispersed, radiation-produced barriers. Comparison of resistivity and yield stress annealing results shows that the magnitude of the increase in yield stress is at all times determined by the remaining defect concentration. Approximately 85% of the defect barriers, probably interstitials, anneals out in Stage I (below about 60°K). The interstitials which remain after Stage I annealing may be either free or trapped by impurities. No significant difference between the hardening at 20°K and that which persists after Stage I has been observed when the results are normalized for differing defect concentrations. Yield point effects, which occurred above 60°K, have been observed in irradiated samples only after low temperature deformation. (auth)

13019 SOLUBILITY OF NITROGEN IN TANTALUM. Griffiths, R.; Pryde, J. A. (Sir John Cass Coll., London). Trans. Faraday Soc., 63: 2599-2604(Nov. 1967).

The solubility of nitrogen in a vigorously degassed atomically clean tantalum wire was studied using ultra-high vacuum techniques. Over the pressure-temperature-concentration ranges 10^{-8}–10^{-3} torr, 1600 to 2300°K and 0.0044-1 atomic %, respectively, ideal solution behavior of nitrogen in tantalum is exhibited, the following expression describing the solution data, $C = (4.4 \pm 0.4) \times 10^{-4} \sqrt{P_e} \exp[(48 \pm 2)10^3/RT]$ where C is in atomic %, P_e is the equilibrium pressure in torr, and T the temperature in °K. The standard partial molar entropy of solution is $-(15.5 \pm 3)$ cal deg.$^{-1}$ g atom^{-1}. This value is in good agreement with a theoretical entropy calculated from disorder and vibrational contributions. The model used to calculate the vibrational entropy is an isotropic three-dimensional Einstein linear oscillator. (auth)

13020 THERMAL STRESS RESISTANCE OF REFRACTORIES. 2. HIGH-TEMPERATURE APPARATUS TO OBTAIN THERMAL CONDUCTIVITY AND FRACTURE TEMPERATURE DIFFERENCE. Prantskyavichyus, G. A.; Dauknis, V. I.; Yurenas, V. L. (Inst. of Physical-Technical Problems in Power Engineering, Vil'nyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B, 3: 121-6(1967). (In Russian).

An apparatus is described which was used to study thermal conductivity, fracture temperature difference and the rate of heat flow of refractories at temperatures to 2300°K in vacuum at inert gas atmospheres. For thermal conductivity measurements a radial steady-state heat flow method was employed. Specimens were heated from a resistance external molybdenum heater. Radial heat flow was changed from the inside by a tungsten heating element. For stress resistance determinations temperature gradient was increased in small steps until fracture occurred. The apparatus was used to study zirconia. (tr-auth)

13021 SURFACE SUPERCONDUCTIVITY IN DILUTE TYPE II ALLOYS. Lowell, J. (Oxford Univ.). Phil. Mag., 16: 581-91(Sept. 1967).

Strip samples of a dilute Ta–Nb alloy exhibit superconductivity up to a maximum field which is in close agreement with the critical field of the surface sheath, providing that the surface is carefully prepared. In other surfaces much larger critical fields are observed, which appear to be associated with a decrease in mean free path due to lattice defects. The magnitude of these effects suggests that the degree of damage near to the surface may be very much greater than that induced in the bulk by any normal deformation process. (auth)

13022 THE α AND β PEAKS IN COLD-WORKED NIOBIUM. Stanley, M. W.; Szkopiak, Z. C. (Univ. of Surrey, London). J. Mater. Sci., 2: 559-66(Nov. 1967).

Internal-friction measurements (at 1 cps) were carried out at 90 to 290°K on niobium specimens deformed at room temperature. Measurements of as-cold-worked niobium revealed a broad peak at about 115°K (α peak). The α peak increased with the amount of deformation and decreased with increasing interstitial impurity content. On subsequent annealing the height of the peak decreased by about 50% at 90 to 140°C, and to negligible values at 250 to 340°C. As a result of annealing for 2 hr at 70°C a group of peaks (β peaks) occurred at about 200°K. The β peaks were independent of the amount of deformation prior to annealing and the interstitial impurity content. On further annealing the relaxation strength of the peaks increased with temperature up to about 100°C, remained constant at 100 to 240°C, and subsequently gradually decreased to negligibly low values at about 340°C. The α peak, and its variation with deformation, impurity content, and annealing, can be accounted for in terms of relaxation mechanisms involving dislocations (i.e., a Bordoni- or Hasiguti-type process observed in fcc metals). The β peaks, on the other hand, could only be adequately accounted for by relaxation processes involving complexes of deformation-created point defects and interstitial impurities. (auth) (UK)

13023 FATIGUE OF MAGNESIUM AT HIGH TEMPERATURE. Skelton, R. P. (Central Electricity Generating Board, Berkeley, Eng.). Metal Sci. J., 1: 140-4(Sept. 1967).

High-frequency (10 to 1700 cps) push/pull fatigue tests on a magnetism alloy at 0.75 of the melting point show that the rate of fatigue-hardening generally increases with increasing frequency and stress level. The time to onset of major crack propagation is virtually independent of frequency, though decreasing slightly at the higher frequencies. Beyond this point the rate of crack propagation may be either time- or cycle-dependent, according to stress level. Fatigue specimens show marked grain growth at a rate that increases with increasing stress level. High-frequency tests are associated with less growth and enhanced boundary cavitation. Smaller grains give rise to less overall plastic strain than large grains, and evidence is presented in grain-boundary sliding during fatigue. (auth)

13024 STAGE III ANNEALING STUDY OF ELECTRON-IRRADIATED ALUMINUM AND DILUTE ALUMINUM ALLOYS. Lwin, Yan Naing. Urbana, Ill., Univ. of Illinois, 1967. 188p.

Thesis.

Zone-refined Al and Al–Mg, Al–Ag, Al–Au, Al–In and Al–Zn alloys were irradiated with 2 MeV electrons near 80°K. The highest integrated flux of 6.8×10^{18} e/cm^2 produced a resistivity increase of 2.46×10^{-9} Ω cm in high purity Al specimen. The enhancement of production was observed for Al + Ag and Al + Mg alloys, but not for the other alloys. Isochronal annealing measurements were made in the region from –130°C to 20°C for pure Al and Al alloys. Some of the specimens were isothermally annealed in steps of 20°C for 64 minutes at each temperature from –130°C to 75°C. The main Stage III peak in pure Al was centered about –45°C and two small recovery peaks were found in the low-temperature side of the main Stage III peak. The alloy also showed three distinct peaks as were in pure Al. The second peak B is more pronounced in the alloys, particularly with Al + Mg and Al + Ag alloys. The main peak C is not affected by alloying. The activation energy for the Stage III defect in pure Al was determined by using the change-of-slope method and found to be $E_{III} = 0.62 \pm 0.04$ eV. The main Stage III peak obeyed second-order kinetics. Activation energy spectra were calculated directly from the isothermal and isochronal annealing curves. The spectra showed that the main Stage III peak was centered at about 0.60 ± 0.02 eV for pure Al and the two small recovery stages in the low-temperature side of the main Stage III peak were also present. The shape of recovery spectrum above Stage III region of Al + Ag alloy differed markedly from other alloys. This was attributed to the formation of G-P zones. Existing models that had been suggested to explain the annealing of Stage III are discussed. (Disser. Abstr.)

13025 CONTROL OF CAST STRUCTURE OF ALLOYS FOR HIGH TEMPERATURE SERVICE. Ramseyer, Stephen Frederick. Cleveland, Case Inst. of Tech., 1966. 106p.

Thesis.

From a survey of the Ni–W and Co–W systems, it was shown that the majority of the binary alloy structures could be successfully modified with substantial improvements in stress rupture properties. From this survey a Co–35W composition was chosen for further investigation and development. In subsequent alloying of the Co–35W alloy, it was determined that additions of Cr, Ti, Zr and C refined and modified the base structure, thus imparting improved properties. Using an alloy of Co–35W–3Cr it was found that the atomic ratio of Ti plus Zr to C determined both the type and morphology of the second phases that formed. The addition of Mo, V, Ta + Nb and N to a Co–35W–3Cr–1Ti–1Zr–.5C–.1B alloy adversely influenced both structure and properties. Several of the alloys investigated had better stress rupture lives at 1850°F than the majority of cobalt-base superalloys cited in the literature. Variations in casting procedure were found to have only minor influence on the structure and high temperature properties of a Co–35W–3Cr–1Ti–1Zr–0.5C–0.1B alloy. Generally, the improvement in properties was associated with a refinement of the dendritic structure and a change in the size and morphology of the microconstituents. A correlation between microconstituent spacing and the time to fracture at constant stress and temperature was observed. (Disser. Abstr.)

Structure and Phase Studies

Refer also to abstract 13896.

13026 (UCRL-Trans-10158) SOLUBILITY OF IRON AND MANGANESE IN MAGNESIUM AND MAGNESIUM–ALUMINUM ALLOYS. Beerwald, A. Translated by W. E. Jones for Univ. of California, Lawrence Radiation Lab., Livermore, from Metallwirtschaft, 23: 404-7(1944). 15p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The solubilities of Fe and Mn in Mg and Mg–Al alloys were investigated. The procedures used for the preparation, sampling, and analysis of test melts to which Fe and Mn were added are described. The results are presented in graphic form and show the effect of Mn concentration on the solubility of Fe in pure molten Mg, and the effect of Al content on the solubility of both Fe and Mn in Mg–Al alloys. (L.C.L.)

13027 PLASTIC DEFORMATION OF TANTALUM SINGLE CRYSTALS. II. THE ORIENTATION DEPENDENCE OF YIELD. Byron, J. F. (Liverpool Univ.). J. Less-Common Metals, 14: 201-10(Feb. 1968).

The plastic deformation phenomena associated with the yielding of single crystals of tantalum are described as a function of orientation at 273°K and 77°K in tension and at 293°K and 77°K in compression. The orientation dependence of the yield stress in tension was found to be consistent with a critical resolved shear stress law for slip on a {110} ⟨111⟩ system for the whole orientation range at 273°K and part of the orientation range at 77°K. The results are interpreted in terms of the Chen and Maddin model of composite slip on non-parallel {110} planes sharing the same slip direction. The anomalies in the orientation-dependence of the yield stress in tension at 77°K are discussed in terms of the asymmetry of slip on {112} planes, and the reduced mobility of jogs in certain orientations. The orientation dependence of the yield stress in compression was not consistent with any critical resolved shear stress law. (auth)

13028 BRIGHT-FIELD OPTICAL MICROSCOPY OF BERYLLIUM. Grotzky, V. K.; Fraikor, F. J. (Dow Chemical Co., Midland, Mich.). J. Less-Common Metals, 14: 244-6(Feb. 1968).

A method for examining the microstructure of Be under bright-field illumination was developed. The specimen was mounted in a suitable hot or cold mount, ground, and polished. Using a stainless steel cathode and the specimen as the anode ~70 V was applied for 1 to 4 min. Recrystallized grains, deformation twins, and the substructures of cold- or warm-worked Be were successfully examined under bright-field illumination. (F.S.)

13029 CHARACTERIZATION OF THE STRAIN RATE DEPENDENCE OF THE SHEAR STRESS FOR NIOBIUM SINGLE CRYSTALS. Armstrong, R. W. (Brown Univ., Providence); Reed, R. E.; Guberman, H. D. Scr. Met., 1: 83-7(Nov. 1967).

Two alternative descriptions for characterizing the temperature and strain rate dependence of the resolved shear stress for single crystals involve the relations $m' = (d \ln \dot{\gamma}/d \ln \tau)T$ and $v^*/kT = (d \ln \dot{\gamma}/d \tau_{th})T$, where $\dot{\gamma}$ is the shear strain rate, τ is the applied shear stress, τ_{th} is the thermal component of the applied

shear stress, and v* is an activation volume. The data showed that m′ increased as the flow stress increased while v* was essentially constant for all samples. According to the thermal activation rate analysis underlying the 2nd relation (see above), v* is solely a function of τ_{th}. The near constancy of v* implies that τ_{th} is similarly constant, independent of strain and growth history for the crystals. By taking into account the thermal activation rate analysis data, the left hand sides of the 2 above equations could be related by: $m' = \tau(d \ln \dot{\gamma}/d \tau_{th})_T = \tau(v^*/kT)$. Since v* is essentially constant, m′ must vary directly as τ, verified by comparison of m′ values with the values of τ. Thus, variation in τ with strain and crystal growth history is only in the athermal component of the applied stress. The last equation may prove useful for determining the values of m′ at small strains. Niobium single crystals, grown with electron-beam floating-zone techniques with the rod axis close to (491), were characterized by these parameters. The m′ and v^*/kT values determined as a function of the compressive shear strain are tabulated. All comparison tests showed a well-defined yield drop and the first strain rate change was made after the lower yield load had been reached. The tests were interrupted for either stress relaxation measurements or x-ray analyses. (BBB)

13030 PHASE DIAGRAM OF THE $NbCo_2$–$ZrCo_2$ ALLOY. Bataleva, S. K.; Sokolova, I. G.; Kuprina, V. V.; Sergeeva, A. M.; Guzei, L. S. Vestn. Mosk. Univ., Ser. II. Khim., No. 4, 119-21 (July-Aug. 1967). (In Russian).

Studies of the $NbCo_2$–$ZrCo_2$ section in the Nb–Zr–Co constitution diagram revealed the compounds $NbCo_2$ and $ZrCo_2$, which formed congruently at 1520°C ($NbCo_2$) and 1560°C ($ZrCo_2$). Microscopic analyses of specimens, subjected to various thermal treatments, showed the typical solid solution structures and the absence of polymorphous transformations. X-ray analysis of annealed specimens revealed only a cubic lattice of the $MgCu_2$ type. Tabulated data on the hardness of the alloys studied confirmed the total miscibility of the system in the solid and liquid states. (R.V.J.)

13031 TRANSFORMATION MECHANISMS IN U-1.5% Mo ALLOY ON RAPID COOLING FROM THE γ-PHASE. Giraud-Herauld, F.; Guillaumin, J.; Sifferlen, R. (Societe Industrielle de Combustible Nucleaire, Veurey-Voroize, France). J. Nucl. Mater., 25: 16-23(1968). (In French).

Rapid cooling of U–Mo 1.5 wt % (3.6 at. %) alloys from the γ phase domain led to the formation of a structure consisting of pearlitic material along grain boundaries and surrounding inclusions, and oriented or martensitic material in the matrix. Study of the cooling diagram of this alloy combined with metallographic examination revealed an intermediate transformation region, associated with a transition structure, the morphology and crystallography of which were established accurately by electron microscopy. This structure, of Widmanstätten type, consists of submicroscopic plates of α phase supersaturated in molybdenum, combined with residual γ matrix, the two phases having the following orientation relationship: (111) γ // (100)α; (11$\bar{2}$) γ // (010)α; (1$\bar{1}$0) γ // (001)α. These characteristics imply that the structure is produced by oriented (coherent) nucleation followed by a growth process involving short-range solute diffusion. This mechanism, intermediate between shear-type (martensitic) transformations and those taking place by oriented or discontinuous precipitation controlled by diffusion, confirms the transitional nature of this structure. (auth)

13032 PHASE EQUILIBRIA IN ALUMINUM–URANIUM–ZIRCONIUM ALLOYS IN THE ALUMINUM-RICH REGION UAl_2–$ZrAl_2$. Petzow, G.; Exner, H. E.; Chakraborty, A. K. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Nucl. Mater., 25: 1-15(1968). (In German).

The constitution of the ternary partial system Al–UAl_2–$ZrAl_2$ was established by metallographic and x-ray studies of as-cast and annealed samples as well as by differential thermoanalysis. The surfaces of primary crystallization, the course of the melt grooves, nonvariant equilibria (1370, 1330, 660, and 640°C), two isothermal sections (1300 and 600°C), and three temperature-concentration diagrams gave a good representation of the constitutional diagram. The system was dominated by extended heterogeneous phase equilibria involving the intermetallic phase UAl_3 in most cases. While UAl_3 was able to dissolve up to 16.9 at. % Zr, the solubility of Zr in UAl_4 was very small. The process of the reaction implies an extended two-phase range marked by UAl_3 inclusions in an Al matrix, a fact that could make the use of Al-rich Al–U–Zr alloys interesting as reactor fuel. (auth)

13033 STATISTICAL-MECHANICAL INTERPRETATION OF THE SOLUBILITY ISOTHERM OF HYDROGEN IN THE HYDRIDE PHASE FOR Pd, V, Nb, AND Ta. Bucur, R. V.; Crisan, M. (Inst. of Atomic Physics, Cluj). J. Phys. Chem. Solids, 28: 995-1000(June 1967). (In French).

A statistical–mechanical interpretation of the phenomenon of dissolution of hydrogen in the hydride phase of Pd, V, Nb, and Ta is presented on the basis of a model in which the association of atoms in pairs in the vacant lattice sites is assumed. The behavior of perfect solid solutions of these hydrides is described. From this, an equation for the solubility isotherm (Longmuir type) is deduced, which can be verified experimentally. (auth) (UK)

13034 ORDERING AND THE K-STATE IN NICKEL-MOLYBDENUM ALLOYS. LeFevre, Bruce Gordon. Gainesville, Fla., Univ. of Florida, 1966. 239p.

Thesis.

Studies were made on Ni–Mo to determine the role of short-range order on the formation of the K-state. Polycrystalline specimens containing 10.5, 14.0, and 20.0 at. % Mo were studied by means of electrical resistivity, x-ray diffuse scattering, electron transmission microscopy, field-ion microscopy, and x-ray small-angle scattering. K-state can be formed in Ni–Mo alloys and short-range order exists in the α-phase region; however, no direct correlation has been made between short-range order and the K-state in this system. It was found that when specimens are treated in such a way that the resistivity increases, there is also a significant increase in the degree of short-range order, and conversely. A possible explanation of how short-range order increases the resistivity in Ni–Mo alloys was provided by field-ion micrographs of specimens in the ordered and disordered conditions. Ni-14.0 at. % Mo specimens were quenched from the α-phase region and compared with Ni-20.0 at. % Mo alloys which had been annealed to develop the fully ordered Ni_4Mo structure (β phase). From a comparison of the two it was concluded that short-range order in dilute Ni–Mo alloys consists of small, imperfect domains of Ni_4Mo-type long-range order, approximately 50 Å in diameter. It is suggested that the resistivity increase is caused by a decrease in the number of effective electrons as the degree of short-range increases. A rough calculation shows that as a result of the Ni_4Mo-type of ordering, the Fermi surface lies closer to a Brillouin-zone boundary than for the case of a random solid solution. The early stages of precipitation of the β phase was studied in the Ni-14.0 at. % Mo alloys by means of resistivity, electron microscopy, and small-angle scattering. It was concluded that the small domains which make up the short-range order in the α phase provided nuclei for the precipitation of the β phase at lower temperatures. By direct observation of the precipitation process in an electron-microscope hot stage it was found that the β phase grows directly into platelets without the occurrence of any intermediate metastable phases. The habit plane of the platelets was found to be the {111}. (Disser. Abstr.)

Radiation Effects

13035 (BNWL-473, pp 11.1-7) FAST REACTOR DOSIMETRY AND DAMAGE ANALYSIS. Nightingale, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

An EBR-11 dosimetry experiment has been completed and analyzed. Neutron fluxes have been calculated from several different types of neutron monitors for in-core positions. (auth)

13036 (BNWL-473, pp 7.1-71) IRRADIATION DAMAGE TO REACTOR METALS. Bement, A. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Inconel 120 has been irradiated to a fast fluence of 1.37×10^{21} n/cm^2 (E > 1 MeV). Results of tensile tests show little difference in properties from those of specimens exposed to lower fluence levels. A total of 42 specimens was discharged from the ETR. Tensile data have been recorded, processed, and stored in the REM computer program for 5140 individual tests. AISI Types 304 SS, 348 SS, 410 SS, and AM 350 SS were irradiated in the ETR hot water loop at 290°C. Results from tensile tests at 1350°F on Inconel 600 and Hastelloy X 280 specimens held as controls for those irradiated at 1250°F to a fast fluence of 1×10^{20} n/cm^2 (>1 MeV) and metallographic examinations indicate that thermal exposure at this temperature causes significant hardening and ductility loss as a result of precipitation reactions. Preliminary data from stress-rupture tests of Inconel X-750 at 1350°F indicate that irradiation at 540°F to a fast fluence of 1×10^{20} n/cm^2 decreases rupture life by 68%. In-reactor creep rupture test results on AISI 304 SS have indicated a much greater effect of irradiation on rupture life at 840°C than at lower temperatures. A faster second-stage creep rate has been observed during irradiation than in an unirradiated control test of heat-treated Zr–2.5 wt.% Nb at a stress of 25.6 kg mm^{-2} and 300°C. Uniaxial creep tests performed on longitudinal sections of Zircaloy-2 pressure tube material at 31.6 kg mm^{-2} stress and 300°C have resulted in

a faster in-reactor creep rate than the corresponding creep rate for the unirradiated control specimen. The fracture toughness of Zircaloy-2 has been determined after cold work, hydrogen charging, irradiation, and on out-of-reactor specimens. Annealing irradiated, cold-worked Zircaloy-2 at 475°C produced a significant increase in toughness in the first 50 minutes. A study was begun to determine the size effects on the fracture toughness of low-strength, high-toughness steels using the double cantilever beam 0.5 in. and 1 in. thick DCB specimens and tests made on a quenched and tempered 4 in. thick plate of A302-B steel. The high pressure forms of Zr, Ce, InTe, CdS, Gd_2O_3, RbCl, and benzene were produced and x-rayed. The high pressure polymorphs of Zr, InTe, and Gd_2O_3 were quenched to ambient condition. The cubic-monoclinic transformation in Gd_2O_3 is reported and the first known x-rays of crystalline benzene at 22°C and 11 kbars were obtained. Zircaloy-2 tensile specimens were examined after G-7 loop exposures. Sixty tubular Zircaloy-2 and Zircaloy-4 corrosion specimens were exposed 209 days in the Plutonium Recycle Reactor. Corrosion studies in the ATR model gas loop demonstrate that molybdenum and tungsten do not undergo chemical reaction with the impurities in helium gas stream. Haynes 25 and Hastelloy X lose volatile alloy constituents by an evaporation mechanism in some test locations and oxidize in other locations. Irradiation pins containing 50 specimens of AISI 304 and 348 SS in the annealed and cold-worked condition have been discharged from the EBR-II. Postirradiation thin film transmission electron microscopy of annealed 304 SS irradiated in the EBR-II has shown that the damage state consists of Frank loops and polyhedral voids. Liquid sodium capsule GEH 22-4 continues operation at peak sodium temperature of 1400°F. The building which will house the testing facilities is in design stage and progress in all areas is reported. (J.C.W.)

13037 (ORNL-TM-2019) EFFECTS OF IRRADIATION ON DUCTILITY. Stiegler, J. O.; Weir, J. R. Jr. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 55p. (CONF-671051-1). Dep. CFSTI.

From American Society for Metals Seminar on Ductility, Cleveland, Ohio.

Aspects of metal deformation and fracture at high and low temperatures are discussed. An introduction is given to the concepts involved in neutron irradiation and to changes in the lattice introduced by irradiation. These are illustrated by electron micrographs of irradiated materials. Changes in mechanical properties as a result of irradiation are described and explained in terms of the corresponding microstructural changes. (J.R.D.)

13038 (WAPD-TM-471(Add.1)) ADDITIONAL STUDY OF MODELS FOR RADIATION DAMAGE EXPOSURE. Shure, K. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Nov. 1967. Contract AT(11-1)-Gen-14. 12p. Dep. CFSTI.

Available data on the change in transition temperature for A302B pressure vessel steel have been correlated with irradiation exposure based on a step function damage model for several threshold energies. Correlations using a 0.4–0.5 MeV threshold energy predict transition temperature changes comparable to those previously obtained using an energy dependent damage model. (auth)

13039 (CEA-tr-A-1912) FRAGILISATION A HAUTE TEMPERATURE DES ACIERS AUSTENITIQUES ET DES ALLIAGES A BASE DE NICKEL PAR DES REACTIONS (n,α). (High Temperature Embrittlement of Austenitic Steel and Nickel Base Alloys by the (n,α) Reaction). Boehm, H.; Dienst, W.; Hauck, H. Translated into French from Z. Metallk., 57: 352-7(1966). 20p. (In French). Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The origin of the embrittlement of austenitic steels and Ni base alloys by (n,α) reactions is believed to originate in the formation of He which is accumulated at the grain boundaries in bubbles. A mechanism is proposed that explains the fact that the appearance of He bubbles exercises an effect only at high temperatures. Expressions for the relation between the embrittlement and the dose rate are obtained by an evaluation of the number of bubbles and their size. The effect of the B concentration, the grain size, and the resistance of the impurities on the initiation of the embrittlement are evaluated. (J.S.R.)

13040 METALLURGY AND STRUCTURAL MATERIALS. THEIR ADAPTATION IN NUCLEAR INDUSTRY. Narcy, J. Atompraxis, 13: 527-9(1967). (In German).

In nuclear reactors the structural materials are subjected more or less to radiations. They must not disturb the neutron flux and must retain their mechanical properties as long as possible. The metallurgical industry faces a hard task in adapting known materials and developing new materials to combine these requirements. The materials and alloys developed in the past years and used for nuclear technology are reviewed. (auth)

13041 EXPERIENCE GAINED WITH THE IN-PILE SODIUM LOOP FOR FAST NEUTRON IRRADIATION AFTER THE FIRST RUN IN THE BR-2 REACTOR. Soenen, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Contract 006-60-5/BRAB. pp 297-341 of Alkali Metal Coolants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria. See STI/PUB-143; CONF-661110.

A high performance in-pile sodium loop has been built for irradiation of fuel pins under fast neutron conditions in the high flux test reactor BR-2 (Mol, Belgium). Descriptions are given of in-pile section of the loop after the irradiation, dismantling in the high-activity hot cell, and visual examination of the sodium circuit during cutting. General descriptions of loop circuitry, control, materials, inspection and testing program, and operational characteristics of the major items are given to illustrate working conditions of the loop. Problems of design and construction of the in-pile section of the loop, sodium-water reactions, sodium activation, fission products' detection, and neutron screening are reviewed and heating, compactness, and regulation of the loop are described. The use of a water mock-up to study some particularities of the design and development work done for an efficient sodium vapor-overflow trap are described. Dismantling procedure followed in the BR-2 high-activity hot cell to recuperate the fuel pins and to permit adequate evacuation of the sub-assemblies and the scrap is described. Visual examination of the sodium circuit during cutting is described along with cleaning and maintenance of equipment. (auth)

13042 STAGE III RECOVERY IN NEUTRON-IRRADIATED TUNGSTEN. Keys, L. K.; Smith, J. P.; Moteff, J. (General Electric Co., Cincinnati). Scr. Met., 1: 71-2(Nov. 1967).

Three polycrystalline W specimens were irradiated at reactor ambient temperatures (~70°C), in a water-moderated reactor, to fast-neutron fluences (>1 MeV) of 3.3×10^{19}, 1.1×10^{20}, and 1.5×10^{21} n cm^{-2}, respectively, after receiving a 1-hr anneal at 1900°C in Ar. The thermal-neutron fluences were in the range of 2 to 5 times the fast-neutron fluences. An isochronal resistivity study of the Stage III (~0.15 T_m) recovery of the irradiated specimens indicated a shift of this recovery region to lower temperatures with increasing fast-neutron fluence. The peak temperature of the recovery spectrum varied from 319°C for the lowest fluence specimen through 307°C for the intermediate fluence specimen to 270°C for the highest fluence specimen. This temperature region was considered as a single recovery stage, however, possibly involving more than one recovery process, because of the observable temperature shift. The shift in peak temperature is in agreement with expectations for secondary pair recovery. The peak shift is believed to result from the effects of transmutation products produced by the thermal neutrons. Such a transmutation product would be rhenium produced as a result of thermal neutron (n,γ) reactions with tungsten. It would probably occupy a substitutional lattice site. (BBB)

13043 EFFECT OF IONIZING RADIATION ON A DIFFUSED INTEGRATED CIRCUIT RESISTOR. Bonis, Scott Andrew. Syracuse, N. Y., Syracuse Univ., 1967. 118p.

Thesis.

A technique is developed for analyzing the effects of ionizing radiation on diffused integrated circuit resistors. Measurements made on specially constructed silicon integrated circuit resistors in a 150 kyp flash x-ray environment were in substantial agreement with the predictions obtained from the theoretically derived equivalent circuit model. (Disser. Abstr.)

Ceramics and Cermets

Refer to abstract 12959.

Corrosion and Erosion

13044 (BNWL-473, pp 3.1-21) FAST FUELS OXIDES AND NITRIDES. Nightingale, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Testing of sodium- and helium-bonded Type 304 SS steel clad mixed uranium–plutonium nitride compatibility capsules was begun. Good wetting between the sodium and the nitride pellets was observed. No reaction between the sodium and 304 SS or the mixed nitride pellets was apparent after 100 hr of heating at 650°C. There was some evidence of sodium penetration and mechanical disintegration of the nitride pellet. No reactions were seen in helium bonded test capsules treated similarly. The first compatibility experiment on sodium-bonded mixed oxides in

304 SS cladding was completed, and the fuel pellets were examined. The test consisted of sodium freeze-melt cycling between 90 and 105°C. Comparison with similar nonheated capsules showed no discernible change due to heat-cycling. Techniques used in analyzing uranium–plutonium oxides for chloride, fluoride, metallic impurities, total metal content and density were successively applied to uranium–plutonium nitrides. A technique was developed for use of a gas mass spectrometer for carbon determination and refinements were incorporated for nitrogen and oxygen determination by inert gas fusion. Four experimental fuel pins containing mixed nitride (UN–20 wt % PuN) pellets were charged into the ETR–MTR. Two pins were discharged from the ETR after successful irradiation to about 2000 MWd/t and are being returned for destructive examination. Equipment for studies of formation of UO_2–carbon mixtures via spray calcination of UNH-sugar solutions has been completed and tests are underway. (auth)

Preparation and Fabrication

Refer also to abstracts 12404, 12486, 12490, 12497, 14209, and 14314.

13045 (AAEC/TM–401) AN IMPROVED METHOD FOR EXTRUDING AND SINTERING BERYLLIUM OXIDE. Bardsley, J.; Ridal, A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug. 1967. 17p. Dep.

A technique for the extrusion and sintering of beryllium oxide to produce high density, fine-grained, high strength material was modified and improved. This resulted in beryllium oxide (250 ppM Fe) which, after extrusion and sintering for 5 hours at 1400°C in nitrogen, had an average grain size of 6 μm, a mean modulus of rupture equal to 34,840 psi when tested in 4-point bending, and a density range of 2.86 to 2.90 g/cm^{-3}. Further modifications reduced the variations in grain size and density of the sintered specimens and increased the mean modulus of rupture. For example, double extruded material, when sintered for 6 hours at 1400°C in nitrogen had an average grain size of 8 μm, a density of 2.92 g/cm^{-3} and a mean modulus of rupture of 45,300 psi. (auth)

13046 ON THE HABIT PLANES OF THE SUBOXIDE PHASES TaO_y AND TaO_2. Van Landuyt, J.; Wayman, C. M. (Univ. of Illinois, Urbana). J. Less-Common Metals, 14: 248-50(Jan. 1968).

In a model proposed for the initial stages of the oxidation of Ta, O was dissolved interstitially in the Ta lattice until in a layer near to the surface, a high enough concentration was reached for the transformation to the TaO_y phase to occur. As oxidation proceeds TaO_2 is formed. A layer of gray pentoxide film will consume the TaO_y. (F.S.)

13047 BERYLLIUM OXIDE. MATERIALS FOR ENGINEERS, NO. 8. Livey, D. T. (Atomic Energy Research Establishment, Harwell, Eng.). Engineer, 223: 347-9(Mar. 3, 1967).

The occurrence of BeO and the extraction processes used are discussed. Fabrication routes considered are pressing and sintering, extrusion and sintering, slip casting and sintering, and hot pressing. Mechanical, thermal, electrical, and other properties are summarized, and applications are reviewed. (UK)

13048 ON THE PRODUCTION OF URANIUM NITRIDES FROM URANIUM(III) CHLORIDE. Tschirne, G.; Naumann, D.; Burk, W. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 10: 272-3(Sept. 1967). (In German).

Uranium nitrides have been produced by reduction of UCl_4 by hydrogen followed by ammonolysis of UCl_3, and their properties have been studied. The reactions were carried out in a quartz apparatus which was fit for producing large amounts by agitation of powder by a tungsten stirrer. The products obtained were free from chlorides within the limits of detection, but had very low size of particles. (auth)

13049 PRODUCTION OF URANIUM CARBIDE FUEL FOR THE DOR REACTOR. Vesely, Vladimir (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez); Kortus, Josef. Jad. Energ., 13: 447-53(1967). (In Czech).

Preliminary data are given on the design, technology, and economics of a plant for production of fuel elements for the organic-cooled heavy water reactor, DOR. A technological assessment is made of two variations considering sintered tablets or fused smelted rods with sintered aluminum (SAP) fuel cans. The plant was designed to produce fuel material, cans and other parts of the element using SAP. The cost of the projected plant for the first variant is 204 krone/Kg U and for the second variant 209 krone/Kg U. The plant will employ 375 workers. Production costs for the first and second variants are 144 krone/Kg U and 125.60 krone/Kg U, respectively, without considering the cost of uranium. (tr-auth)

13050 SOME EXPERIMENTS ON VIBRATIONAL COMPACTING OF B_4C FOR REACTOR CONTROL RODS. Rutkowski, W.; Szteke, W.; Wieczorkowski, M. Nukleonika, 12: 1047-55(1967). (In Russian).

Experiments on the vibrational densification of the B_4C core were made within the scope of the reactor control rod investigation program. Higher densities of the B_4C cores were obtained when using the hot-pressing technique. Lower densities could be obtained in a vibrational densification process. The control rods were tested in the reactor. The experimental results are given. (auth)

13051 ELECTRICAL DISCHARGE SINTERING AND GRAPHITIZATION OF CARBON POWDERS. Honda, H. (Resources Research Inst., Kawaguchi-Saitama, Japan); Kobayashi, K.; Inoue, K.; Ishiyama, M. Carbon, 5: 545-8(Nov. 1967).

Instantaneous sintering and graphitization by electrical discharge were examined using amorphous carbon powders such as petroleum coke, thermal black, Akabira coal and Akabira-coal coke, in order to obtain compact graphitized carbon solids. A graphite capsule was filled with a carbon powder compressed by a pressure in the range from 175 to 350 kg/cm^2 and an electrical pulse current was passed through the carbon powder for 60 to 600 sec. A compact disc-like solid of sintered graphitized carbon was obtained. The degree of sintering and graphitization of the compact carbon solid was examined by microscope and x-ray analysis. A more compactly sintered carbon solid was obtained from petroleum coke and thermal black for a longer discharge duration. Some of the sintered carbon solids gradually decomposed back into fine powder within a month. The x-ray data show that graphitization occurred in all the carbon solids; its degree was higher for specimens which were subjected to higher discharging energy. While the sintered petroleum coke showed a single (002) profile, the sintered thermal black and the Akabira coal showed composite (002) profiles with a d spacing of 3.44 – 3.42 Å (broad component) and 3.36 Å (narrow component), the lines becoming sharper and stronger with increase of the discharge energy. (auth)

13052 FABRICATION METHODS FOR PBI ADHESIVE BERYLLIUM SANDWICH STRUCTURES. Yoshino, S. Y.; Nadler, M. A.; Richter, D. H. (North American Aviation, Inc., Downey, Calif.). Adhes. Age, 10: 26-34(Aug. 1967).

New adhesives were investigated for Be in view of the difficulty of applying welding or mechanical joining methods to Be. Of the standard joining methods, adhesive bonding appeared to be the most compatible with the physical characteristics of Be. The new polyaromatic adhesives possess excellent strength retention at 500 to 1000°F where Be is of interest. Imidite 850, a polybenzimidazole base material, was chosen for investigation because it has a higher temperature capability than polyimides. The strength of adhesive-bonded Be joints as a function of temperature is shown. Lab investigations, and fabrication and testing of preprototype 12-in.-dia sandwich cylinders made from conventional materials, leading to the final Be-Imidite 850 cylinder, are described. The pre-bond surface preparation treatment recommended for Be-Imidite 850 bonding calls for an initial 2 to 5 min etch in 10 to 20% sulfuric acid. Post-curing (750°F) increased the bond strength of Imidite 850 adhesive. In fabrication of the test cylinders advances were made from a simple-structure elemental stage to one permitting manufacture of complex, contoured structures. Test results on the cylinders demonstrated the utility of adhesive bonding as a practical joining method for Be, thus widening potential areas of applicability for this material which is difficult to join by mechanical methods. (BBB)

13053 EFFECT OF BORON LEVEL ON GRAPHITIZATION OF BPG. Kotlensky, W. V. (Raytheon Co., Waltham, Mass.). Carbon, 5: 409-10(Sept. 1967).

The effect of up to 2% boron on the degree of graphitization of BPG (boron pyrolytic graphite) was investigated, and a maximum was found to exist at 0.8 to 1% boron. Annealing at 2,000°C for 20 hr increased the degree of graphitization markedly. (UK)

13054 SINTERING AND GRAIN GROWTH OF THORIA GELS. PART I. SINTERING AND GRAIN GROWTH OF THORIA GELS CONTAINING CALCIUM OXIDE. PART II. EXTENDED STUDY OF GRAIN GROWTH OF THORIA GELS. Im, Suk Joong. Salt Lake City, Univ. of Utah, 1967. 200p.
Thesis.

The effect of calcium impurity on sintering of thoria gel compacts was studied through measurements of shrinkage and grain growth. The thoria gels with various calcium concentrations were obtained by adding calcium nitrate up to 1% by weight. The average grain sizes of initial thoria gels were in the range of 60 to 85 Å, and the maximum average grain size during sintering at 850°C was 300 Å. Grain boundary diffusion was found to explain the sintering data well except for higher temperatures above 850°C. The analysis

of shrinkage data was done by use of a computer. The effect of atmosphere on grain growth of plain gel compacts during sintering was studied in air and hydrogen atmospheres. In addition to the grain size determination, during presoaking and firing, by electron microscopy and x-ray line broadening techniques, the density change was studied on each sample fired in the ambient atmosphere. Thoria gel samples were presoaked at 900°C for several hours in N_2 and H_2 atmospheres and the densities were measured by means of toluene displacement. Considering the densities (approximately 9.2) of the samples presoaked for 4 hours in N_2 and H_2 could approach the theoretical density when they are fired, examinations of average grain size as a function of time were carried out in N_2 and H_2 atmospheres. Similar studies were carried out in N_2 atmospheres at 1150°C after presoaking for 4 hours in N_2 atmospheres. Erratic grain growth was observed in the experiments under various conditions but was not observed for the samples fired at 1150°C for 800 minutes in N_2 atmosphere after presoaking at 900°C for 4 hours in N_2 atmosphere, and for the samples fired at 1050°C for 800 minutes in H_2 after 4 hours presoaking in H_2 atmosphere. (Disser. Abstr.)

13055 PRODUCTION OF STOICHIOMETRIC URANIUM MONOCARBIDE. Murbach, E. W. (to United States Atomic Energy Commission). U. S. Patent 3,345,143. Oct. 3, 1967.

A method was developed for producing uranium monocarbide directly from a uranium fluoride, which comprises contacting the uranium fluoride, silicon dioxide, and carbon at a temperature of at least about 400°C under an inert environment until evolution of the resulting SiF_4 gas is complete, and then increasing the temperature to at least about 1300°C until the reaction is completed. (AEC)

13056 EXTRACTION METHOD FOR PREPARING UO_2 MICROSPHERES. Morse, Leen E. (to United States Atomic Energy Commission). U. S. Patent 3,367,881. Feb. 6, 1968.

A method was developed for making a uranous sol from an aqueous uranous nitrate solution by extracting a portion of the nitrate from the aqueous solution with an organic solution of an amine, permitting the aqueous phase containing a portion of nitrate to adjust to the lowered nitrate conditions, and then extracting additional nitrate from the resulting solution. (AEC)

13057 PREPARATION OF MICROSPHERES. Fitch, Frederick Troop; Braun, Ann Baker (to W. R. Grace and Co.). British Patent 1,099,652. Jan. 17, 1968. Filed Dec. 11, 1964.

A process is described for preparing spherical particles of controlled size containing one actinide metal oxide such as ThO_2 or UO_2 to be used as reactor fuel. The fuel is prepared by forming a sol or aquasol of the actinide metal oxide and a rare earth oxide or zirconia in a liquid medium such as a hydrocarbon, chlorinated hydrocarbon or an alcohol, at a temperature between its bp and 50°C below its bp. Dispersed droplets are allowed to settle through the liquid medium. The droplets are solidified to spherical particles. (F.S.)

13058 PREPARATION OF DENSE THORIA AND SULFATE-CONTAINING THORIA FROM AN AQUEOUS THORIUM NITRATE SOLUTION. Briggs, Gifford G. (to United States Atomic Energy Commission). U. S. Patent 3,370,016. Feb. 20, 1968.

A precipitation process is described for forming thoria from an aqueous solution of thorium nitrate characterized by the addition of ammonium hydroxide while simultaneously bubbling or sparging with carbon dioxide, or by the equivalent operation of adding ammonium carbonate or bicarbonate to the solution. A precipitate will form which can be recovered from the mother liquor and can then be converted to a thoria powder having particles approaching the theoretical density of thoria and a spectrum of particle sizes which include an appreciable percentage which lie in the millimeter size range. (AEC)

Properties Evaluations

Refer also to abstracts 12963 and 13014.

13059 (AAEC/TM-396) SURVEY OF THE STORAGE BEHAVIOUR OF URANIUM DIOXIDE. Bannister, M. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1967. 21p. Dep.

The storage behavior of uranium dioxide powder is reviewed. Topics covered include the amount of oxygen taken up under storage conditions, the basic oxidation processes, the effects of extra oxygen on the fabrication and irradiation behavior of uranium dioxide, the pyrophoric reaction of uranium dioxide powders in air, the stabilization of uranium dioxide against oxidation, and the effectiveness of sealed containers. The pyrophoric process in air at room temperature is shown to be the result of rapid chemisorption of oxygen, and a theory explaining this effect is developed. Equations are also derived to describe the overall oxidation behavior in air at room temperature, and they are found to agree with what few experimental data are available. (auth)

13060 (BNWL-473, pp 4.1-9) NUCLEAR CERAMICS. Nightingale, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The average coefficient of thermal expansion at 20 to 960°C of a stoichiometric $(Pu_{0.20}, U_{0.80})O_2$ specimen was 10.2×10^{-6} in./in.°C. The etching behavior of UO_2–25 wt % PuO_2 solid solutions depends on the O/M ratio. Stoichiometric material (O/M = 2.00) is more resistant to grain boundary attack than hypostoichiometric material (O/M = 1.96). The thermal diffusivity of uranium oxycarbide was measured at 100 to 1500°C as a function of oxygen concentration of 2 to 17 at.% of the anions. The thermal diffusivity decreased as the oxygen content increased. Development of mechanical thinning methods for preparing samples of polycrystalline UO_2 and mixed UO_2–PuO_2 for transmission electron microscopy continued. The electrical conductivity of polycrystalline ThO_2 was measured at 1030 to 2880°K in a reducing atmosphere. Nuclear materials and information exchanges were continued, primarily with domestic research sites. (auth)

13061 (BNWL-473, pp 5.1-19) NUCLEAR GRAPHITE. Nightingale, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Graphite (RC5) continues to show no appreciable growth after an exposure of $\sim 8 \times 10^{21}$ nvt at 950°C. The data for all tested graphites of each orientation are clustered in two groups, one for the temperature range 400 to 800°C and the other for the range 850 to 1275°C. There are appreciably faster dimensional changes in both orientations at irradiation temperatures above 800°C. The dimensional behavior of two nuclear grade materials, NC8 and CSF, are now well defined for small-size samples in the irradiation temperature range of 400 to 800°C. As a result, the capsule design will be modified to investigate the effect of sample size and restraint on the growth rate of graphites after turnaround. Of two highly irradiated transverse samples, the sample which had expanded 20% had very little mechanical strength; whereas, a similar sample, which had expanded only 3%, had the same strength as virgin material. The c-direction lattice expansion in both samples was approximately 1%. Both the loss in strength and the large expansion in excess of the lattice expansion imply crack generation in the sample with 20% expansion. The high temperature graphite irradiation capsule was ruptured at an external tube while being moved in the ETR and had to be disassembled. A new capsule exterior is constructed entirely of stainless steel to increase strength. Two additional graphite pins with estimated maximum exposures of 1.5×10^{22} nvt have been discharged from EBR-II. Specific-heat data have been analyzed to obtain Debye lattice vibration constants. Estimates of the crystal elastic moduli are obtained and are in fair agreement with previous estimates. The length of polycrystalline graphite was measured as a function of temperature while cycling at 1000 to 2400°C. A sample of transverse orientation showed thermal-expansion hysteresis during cycling to 2400 and 2200°C but little or no hysteresis during cycling to 2000 and 1800°C. A sample of parallel orientation displayed no measurable hysteresis when cycled to 2400°C. The existence of hysteresis supports the hypothesis of microcrack formation during cool-down in graphite. Graphite discs which have been thinned in the center are useful for studying gas-graphite reactions. Other samples have been thinned and polished while being supported in an epoxy matrix until an electron beam passes through the sample. (auth)

13062 (BNWL-473, pp 5.19-23) HTGR GRAPHITE. Nightingale, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The Graphite Oxidation Computer Program (GOP) has been used to estimate the rate of graphite oxidation and steady-state gas compositions in a typical High Temperature Gas-Cooled Reactor (HTGR). The calculations indicate that radiation has a relatively large effect on the gas compositions and particularly on the H_2/H_2O ratio. An analysis of a possible accident condition, where the water from one of the heat exchanger units is dumped into the core, revealed a 10% increase in the gas pressure. (auth)

13063 (EURAEC-1885) USE OF PLUTONIUM AS FUEL IN NUCLEAR REACTORS. Quarterly Report No. 12, October 1, 1966–December 31, 1966. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Feb. 1967. Contract 001-64-1-TRUB. 73p. (EUR-3381). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Five and one-half kg of 3% enriched uranium oxide was fused by

the original method. During the production of 112 rods for neutron tests, work continued on studying the major influence of the vibration conditions. The four fuel rods designed for irradiation in the Diorit Reactor were fabricated. The results were analyzed from the rods irradiated in hydraulic conveyor HR 1 in the BR-2 Reactor. Irradiations at a power per unit length of more than 1000 W/cm were performed and the size of the specimens did not change. A fission gas leak from a weld on one of the six specimens was observed. Faults appeared in the irradiation devices in the boiling water capsule tests. The mean burnup ratio was put at 5500 MWd/t at right angles to the hottest specimen. The mean power was 300 W/cm, and the can temperature was 500°C. The examination of the BR-3/PWR fuel rods continued. Puncture, and collection of the fission gas, revealed that the latter's interaction in the rods fabricated by the vibration method with plutonium in the fine grade alone is far superior to that observed on the uranium rods consisting of pellets. A very high release of CO and CO_2 was noted in the rods prepared from Dynapak powders. The BR-3/VN plutonium assembly was inserted in the reactor, reached full power, and operated without incident. The Panther Code was calibrated for calculation of the UO_2 and PuO_2-UO_2 lattices, adding a sub-routine for burnup to the Panther code, adapting the Pendule one-dimensional burnup code for use with Panther constants, and preparing a version of the Panther code processing the canning and fuel of a cell in several regions by the initial collision theory to allow for heterogeneous PuO_2 distribution in the UO_2-PuO_2 rods. The adaptations being made to the VENUS critical facility were completed, apart from the positioning of the grids. The subcritical measurements on the VENUS-Vulcain fuel and the irradiations in BR-1 supplementing the plutonium substitution experiments in VENUS were completed. Progress in fuel economy consisted of making selection among the two-dimensional diffusion codes available, preparing a reference xy geometry for the SENA Reactor which will be compatible with the features of the codes, and examining the principles of assembly repositioning in a SENA-type reactor. (J.C.W.)

13064 (SC-DR-67-793) AN EVALUATION OF MICROWAVE WINDOW MATERIAL AND ABLATION MATERIAL ASSEMBLIES IN SIMULATED RE-ENTRY ENVIRONMENTS. Mead, Keith E. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. Contract AT(29-1)-789. 63p. Dep. CFSTI.

Dielectric materials suitable for re-entry thermal protection of microwave antennas have been built into models of window-ablator combinations. These models have been subjected to simulated re-entry environments in ground test facilities to determine window-ablator compatibility, window thermal excursion rates, and the integrity of window-ablator assembly techniques. Windows tapered for retention and a close fit between window and surrounding ablator were found to be a superior assembly technique. The surface recession of silica and isotropic pyrolytic boron nitride windows closely follows that of the phenolic-carbon ablation material used in these tests. Anisotropic pyrolytic boron nitride stands in relief when used with phenolic-carbon ablator. No serious delamination problems were encountered with anisotropic pyrolytic boron nitride when properly machined and assembled. (auth)

13065 (UCRL-70149) DIFFUSION PATH NETWORKS IN OXIDES. Condit, Ralph H. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 8, 1968. Contract W-7405-eng-48. 32p. (CONF-670625-5). Dep. CFSTI.

From International Symposium on Kinetics of Reactions in Ionic Systems, Alfred, N. Y.

An understanding of diffusion mechanisms in oxides, particularly cation diffusion, must take account of the various possible paths that an atom may follow in going from one normally occupied site to another equivalent site. Such paths may be branched and will likely include stops at metastable points along the way. Methods whereby path networks within oxides can be characterized are described and diffusion in the structures NaCl, ZnS, FeS, and BeO is discussed. (auth)

13066 (LA-tr-67-91) MASS SPECTROMETRIC INVESTIGATION OF THE COMPOSITION OF VAPOR OVER THE TiC-C AND ZrC-C SYSTEMS. Starostina, T. S.; Sidorov, L. N.; Akishin, P. A.; Karasev, N. M. Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 727-8(1967). 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 36931. (P.C.H.)

13067 (LA-tr-68-3) SELF-DIFFUSION COEFFICIENT OF URANIUM IN URANIUM MONOCARBIDE. Villaine, Philippe; Marin, Jean-Francois. Translated for Los Alamos Scientific Lab., N. Mex., from Compt. Rend., 264: 2015-18(1967). 5p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 41534. (P.C.H.)

13068 (WAPD-Trans-82) THE THERMAL CONDUCTIVITY OF URANIUM DIOXIDE AT VERY HIGH TEMPERATURE GRADIENTS. Patrassi, E. Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from J. Nucl. Mater., 22: 311-19(1967). 16p. Dep. CFSTI. JCL $1.60 fs, $1.01 mf.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 26815. (P.C.H.)

13069 EXPERIMENTAL INVESTIGATIONS OF THE ELECTRONIC PROPERTIES OF THE OXIDIZED SILICON SURFACE USING MOS CAPACITORS. Collins, Dean Robert. Urbana, Ill., Univ. of Illinois, 1967. 94p.

Thesis.

Uniform, stable, and reproducible metal-oxide-semiconductor (MOS) capacitors were fabricated for the study of the electronic properties of the oxidized silicon surface. The following results were obtained. X-rays cause a positive effective surface state charge located near the $Si-SiO_2$ interface. The damage caused by the x rays resulted in localized surface states and bulk silicon conversion. The effective surface state charge is stable at room temperature while the localized surface states and the bulk conversion are not. The introduction of gold into the devices causes a negative effective surface state charge. The gold diffuses through the silicon and appears to accumulate at the $Si-SiO_2$ interface. A simple physical model based on this accumulation is used to evaluate the diffusivity of gold. The value of the diffusivity obtained for gold in silicon is in excellent agreement with published values and the value for SiO_2 is previously unpublished and is 1.76×10^9 times smaller than that in Si at 1000°C. The surface state density is a complicated function of process parameters. The non-gold doped devices produced had a surface state density which was continuous across the forbidden band gap. Annealing was found to decrease the surface state density. The surface state density was obtained by two different methods and the results were found to be in excellent agreement. A low and a high frequency capacitance theory including the bulk effects of gold was derived in order to analyze the gold doped devices. The gold increased the surface state density but did not change the shape of the density vs energy curve appreciably. No correlation was found between the shift of the capacitance-voltage curves and surface state density. The effect of gold on the input impedance of a MOS capacitor was measured as a function of frequency and temperature and found to be in excellent agreement with a theoretical calculation based on the complete small signal equivalent circuit. Estimates of the capture cross sections of gold in silicon was made using this theoretical calculation. (Diss. Abstr.)

13070 DOPED, PARTIALLY REDUCED, CERAMIC FUELS FOR NUCLEAR FUEL ELEMENTS. (to Atomic Energy of Canada Ltd.). British Patent 1,099,329. Jan. 17, 1968. Priority date May 3, 1965, United States.

A ceramic-type fuel with improved thermal conductivity is described. Thermal conductivity of UO_2, ThO_2, and ThO_2-UO_2 is improved by incorporation of minor quantities of an oxide of La, Nb, or Y. The fuel dioxide must be in a hypostoichiometric state. (F.S.)

Structure and Phase Studies

Refer also to abstract 12269.

13071 (ORO-3328-7) GRAIN BOUNDARY SLIDING IN ALUMINA BICRYSTALS. Progress Report, April 1, 1967-November 30, 1967. Palmour III, Hayne; Kriegel, W. W.; Becher, P. F.; Witter, D. E.; Huckabee, M. L. (North Carolina State Univ., Raleigh. Dept. of Engineering Research). Dec. 1967. Contract AT(40-1)-3328. 50p. Dep. CFSTI.

Dislocations, subgrain boundaries, and grain boundaries cause characteristic fine topographic features at their surface termini when alumina is thermally etched >1500°C in vacuo; flame grown crystals and pure and doped bicrystals synthesized from them were examined by optical and replication electron microscopy, and typical crystalline defects are illustrated. Knoop indentation microhardness studies on thermally etched surfaces normal to pure and impurity doped (MgO or SiO_2) bicrystal boundaries indicated softening in a band up to 100 μ wide with a minimum at the boundary; easier indentation is attributed to significantly lower concentrations of defects near the boundary and greater likelihood of stress relief by very localized grain boundary shear of the type postulated by Carniglia. A new specimen configuration (designated as a double bicrystal) was successfully fabricated and tested; each specimen contains a central wedge-shaped crystal segment separated from the end segments by nonintersecting,

orthogonal grain boundaries oriented ~45° to the specimen axis. The implications of an orientation-dependent strengthening effect are discussed, particularly with reference to the preferentially oriented, hot worked (press-forged) polycrystalline ceramics developed by Vasilos et al. (J.G.B.)

13072 SOLUBILITY OF CARBON IN SODIUM. Luner, C.; Cosgarea, A. Jr.; Feder, H. M. (Argonne National Lab., Ill.). pp 171-9 of Alkali Metal Coolants. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria. See STI/PUB-143; CONF-661110.

The solubility of carbon in sodium has been reported. Because of the uncertainties in the data, an effort was made to redetermine this solubility. Two sets of experiments were performed: one employed essentially a previous experimental procedure with an improved analytical determination of total carbon; the other involved ^{14}C as a tracer. Results showed that the true solubility of elemental carbon in sodium is less than 0.005 ppM up to 450°C. The experiments indicated that liquid sodium usually contains significant amounts of dispersed carbon capable of passing through a 5 μm stainless-steel filter. The amount of carbon passing through such a filter depends, among other factors, on the previous history of the sodium. Measures of the degree of dispersion of carbon in sodium were furnished by ultra-centrifugation and filtration experiments. The distribution of carbon among its various forms, i.e., dispersed elemental carbon, carbonate, carbide, etc., are discussed. (auth)

13073 PRESSURE-TEMPERATURE-COMPOSITION DIAGRAM OF THE SYSTEM URANIUM-HYDROGEN. Guinet, Ph. (Centre d'Etudes Nucleaires, Grenoble, France). J. Nucl. Mater., 25: 24-37(1968). (In French).

The various diagrams: temperature-composition, pressure-composition, and pressure-temperature, in the uranium-hydrogen system, were drawn, using the most recent data on the solid-gas equilibrium pressure at various temperatures and compositions. These representations bring forth two four-phase invariant equilibria; in both isobaric diagrams for pressures higher than 83 atm and isothermal diagrams for temperatures higher than 820°C, the domains of the two phases $\langle U_\gamma, H \rangle$ (a solid solution of hydrogen in γ-uranium) and UH_n (uranium hydride) joined themselves to make a single phase. The conditions for obtaining noncongruent melting of the hydride were deduced, for either constant pressure or constant temperature. Various types of isobaric or isothermal reactions are discussed with respect to their dependence on temperature or pressure. (auth)

13074 THE DEFORMATION OF ZIRCONIUM-OXYGEN SINGLE CRYSTALS. Soo, P.; Higgins, G. T. (Univ. of Liverpool). Acta Met., 16: 177-86(Feb. 1968).

The rate-controlling mechanisms for $\{10\bar{1}0\}\langle 11\bar{2}0\rangle$ prismatic slip in Zr-O alloy crystals, at 77 to 473°K, have been determined by means of differential strain-rate and differential temperature techniques. Two separate rate-controlling processes occur; below 300°K the rate of deformation is regulated by dislocation-interstitial oxygen atom interactions and at elevated temperatures by the non-conservative motion of vacancy jogs in screw dislocations. These two mechanisms have been found to apply for alloys containing between 135 to 2000 ppM of oxygen. (auth)

13075 DEFORMATION OF ZIRCONIUM-HYDROGEN ALLOYS. Soo, P.; Higgins, G. T. (Univ. of Liverpool). Acta Met., 16: 187-93(Feb. 1968).

Single crystals of zirconium, containing 135 ppM by weight of oxygen as an impurity, have been hydrided to concentrations between 175 to 495 ppM and deformed at 77 to 473°K. Additions of hydrogen gave an athermal increase in the yield stress for prismatic slip, $\{10\bar{1}0\}\langle 11\bar{2}0\rangle$, in both air-cooled and quenched Zr-H alloys and this is interpreted in terms of the stress required to bow dislocations between small hydride particles. Activation volumes and activation energies have also been determined for the thermally-activated mechanisms controlling flow. In air-cooled alloys values similar to those obtained in Zr-135 ppM O alloys are obtained, indicating that the thermal obstacles are the same in each case. On the other hand, in a quenched Zr-355 ppM H alloy the results suggest that the character of the thermally-activated component may be different. (auth)

13076 DEFORMATION OF ZIRCONIUM. Mills, Donald, Toronto, Univ. of Toronto, 1966.

Thesis.

The deformation of zirconium-oxygen alloy single crystals has been studied at 77 to 950°K. A technique was developed whereby the single crystals were grown in the solid state, using steep temperature gradients, in an electron beam furnace. The previous observations of dislocations in zirconium by chemical etching were limited to grown in dislocations. An electrolytic etch pit technique was developed which enabled the distribution of both grown in and glide dislocations to be observed. The course of the polygonization process in bent single crystals of zirconium was studied with the etching technique. Measurements were made of the temperature dependence of the flow stress and of the temperature dependence of the activation energy for the deformation process. The activation volumes associated with the deformation and their temperature dependence were measured by means of a stress relaxation technique. The relaxation was found to be logarithmic with time. The temperature dependence of the flow stress was found to be a direct function of the oxygen content. The measured values of activation volume were associated with the effective spacing of oxygen atoms derived from current solid solution hardening theory. The activation energy for the deformation process was found to vary linearly with temperature up to 560°K; above this temperature the oxygen atoms become transparent to the movement of glide dislocations. The deformation at 600 to 800°K is not apparently thermally activated, and the deformation above 800°K is associated with an activation energy close to that for zirconium self diffusion. (Disser. Abstr.)

Radiation Effects

Refer also to abstracts 13061, 13591, and 13602.

13077 (BNWL-473, pp 6.1-20) BASIC SWELLING STUDIES. Leggett, R. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Capsule P-14 (700°C, 500 psi, 0.2 to 0.8 at.% burnup) was charged into a reactor after capsule P-15 (700°C, 1000 psi, 0.2 to 0.8 at.% burnup) was discharged. Detailed metallographic examination of uranium, plus 4 at.% Mo-0.1 at.% Si alloy specimens irradiated at 510°C at low pressure to 0.45 at.% burnup, revealed the presence of tears as large as 1 μ and tiny fission gas pores about 0.05 μ. Specimens of other alloys showed much more tearing and porosity than did the uranium plus 4 at.% Mo-0.1 at.% Si. Analysis of the first 96-hr, 15,000-psi, 900°C test on unirradiated uranium revealed that some uranium had inadvertently contacted the 304 SS capsule wall and U-304 SS liquid eutectic had formed. Corrosion tests on uranium, isolated from 304 SS but immersed in NaK at 900°C, showed corrosion rates of 221 to 238 mg/cm^2/mo. (auth)

13078 (TID-24233) EFFECTS OF NEUTRON DAMAGE ON THE MECHANICAL PROPERTIES OF PYROLYTIC AND SINGLE-CRYSTAL GRAPHITE. Complete Scientific Report, April 1, 1964-June 30, 1967. Meers, J. T. (Union Carbide Corp., Parma, Ohio. Carbon Products Div.). Sept. 6, 1967. Contract AT(40-1)-3237. 76p. Dep. CFSTI.

The elastic constants of pyrolytic graphite which has been highly ordered by annealing under compressive stress have been determined by ultrasonic, sonic resonance, and static test methods, and the shear modulus of natural graphite crystals was determined by ultrasonic and static shear tests. The following self-consistent set of elastic constants (c_{ij} in units of 10^{11} d/cm^2; s_{ij} in 10^{-11} cm^2/d) has been deduced from the results: $c_{11} = 106 \pm 2$, $c_{12} = 18 \pm 2$, $c_{33} = 3.65 \pm 0.10$, $c_{13} = 1.5 \pm 0.5$, $c_{44} = 0.018$ to 0.035, $1/s_{11} = 102 \pm 3$, $1/s_{33} = 3.65 \pm 0.10$, $s_{12} = -0.0016 \pm 0.0006$, and $s_{13} = -0.0033 \pm 0.0008$. The shear modulus of natural crystals was $c_{44} = 0.01$ to 0.17×10^{11}d/cm^2. The shear strength for shear between basal planes was found to be in the range of 90 to 250 g/mm^2 for the pyrolytic graphite, and in the range of 25 to 76 g/mm^2 for the natural graphite crystals. Neutron irradiations were carried out at exposures of 3 to 71×10^{17} nvt at 50°C, at exposures of 3 to 8×10^{19} nvt at 650°C, and at an exposure of 1.2×10^{20} nvt at 1000°C. The only elastic constant which changed significantly with irradiation was the shear modulus. The natural crystals after irradiation had shear moduli in the range of 0.16 to 0.46×10^{11}d/cm^2, the modulus after irradiation showing no correlation with irradiation temperature, exposure, or modulus before irradiation. The average values of the shear modulus of the pyrolytic graphite were 0.22 to 0.40×10^{11}d/cm^2 after irradiation at 50°C, 0.030 to 0.033×10^{11}d/cm^2 after irradiation at 650°C, and 0.042×10^{11}d/cm^2 after irradiation at 1000°C; the modulus at the irradiation temperatures of 50 and 650°C increased as the neutron exposure increased. The shear modulus c_{44} of graphite when all dislocations are pinned is thus equal to or greater than 0.40×10^{11}d/cm^2. The changes in shear modulus upon irradiation for the pyrolytic graphite and natural crystals are interpreted in terms of the homogeneous nucleation theory of Reynolds and Thrower, which is based on electron microscope observations on irradiated graphite crystals. (auth)

13079 IRRADIATION OF NATURAL UO_2 PELLETS. Taketani, Kiyoaki; Ichikawa, Michio. Nippon Genshiryoku Gakkaishi, 9: 447-54(Aug. 1967). (In Japanese).

Three kinds of capsules containing natural UO_2 pellets were irradiated in the EFTL-2 hydraulic rabbit irradiation facility of JRR-2 to assemble basic data pertaining to EFTL-2 when carrying fuel capsules under irradiation, to ascertain the correctness of capsule design and to compare calculations with experimental data, and to gather information on the effect of irradiation on natural UO_2 pellets of the same dimensions as fuel used in the JPDR. (auth)

Plastics and Other Materials

Refer also to abstracts 12951, 13052, and 14314.

13080 CO_2 GAS CIRCUIT FOR INVESTIGATING RADIATION INDUCED GRAPHITE CORROSION. Muellerthann, M. (Deutsche Babcock and Wilcox-Dampfkessel-Werke AG, Oberhausen, Ger.); Niederstetter, H. Atomwirt., Atomtech., 12: 539-42(Nov. 1967). (In German).

The graphite-CO_2 reaction under irradiation is an important design parameter for graphite-gas reactors. The relationships are known essentially only for low gas pressures and power densities. Experiments which are being carried out in 15 irradiation cycles each of 10.5 days duration are to investigate the conditions at the higher gas pressures and radiation intensities such as are of interest in the newer designs of gas-graphite reactors. The gas composition which will inhibit the reaction is to be determined by varying the composition. In addition the behavior of various sorts of moderator graphite of European manufacture is to be determined. A loop for these experiments was constructed in the Belgian reactor BR-2 in Mol. The design data were so fixed that the graphite specimens can be exposed to a gas velocity of about 20 m/sec and a temperature of 400°C. For reasons of safety the in-pile section of the loop was constructed as a double tube. The installation is concentrated in two compact structures in order to shield it while using gas activated as high as possible. For reasons of safety all valves had also to be equipped with drives. In the first experiments 12 graphite specimens in the form of concentric hollow cylinders of 600 mm length (bore diameter 11 mm, external diameter 26.3 mm) were used. The integrated flux was measured with various dosimeters. Thermocouples were used to measure the temperature of the specimens. Because of the high thermal neutron flux at the specimens a relatively long lifetime for the moderator graphite was simulated in a short time. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 12719, 13243, 13247, 13282, 13345, 13370, 13378, and 13734.

13081 SOLAR ACTIVITY AND ATMOSPHERIC PHENOMENA ON MARS DURING THE YEAR 1956. De Mottoni, Glauco. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 42: 486-90 (Apr. 1967). (In Italian).

The solar activity, referred to the distance of Mars, is considered. It was found that in the days about August 20, 1956, this activity reached an intensity never reached before since 1877 during the periods of observability of the planet. The fact that precisely in those days unprecedented extraordinary events and modifications of the soil of Mars took place is recalled. Pointing out this close relation it is possible to draw the conclusion that the solar activity could have been connected with the genesis of the phenomena observed on the planet. Considering the subsequent opposition of Mars in 1958, the year in which solar activity reached its absolute maximum, it is observed that also in that year similar phenomena (which for the most part escaped telescopic observation) could have happened on Mars. (auth)

13082 STRANGE NOVA DELPHINI. Sky Telesc., 35: 123-5(Feb. 1968).

The behavior of Nova Delphini is briefly discussed and the spectrum is given. (W.D.M.)

13083 GALAXIES AND QUASARS AT PRAGUE. III. Page, Thornton L. (Wesleyan Univ., Middletown, Conn.). Sky Telesc., 35: 90-2(Feb. 1968).

A brief report is given on the discussions on quasars and radio galaxies held at Prague, Aug. 28, 1967. The discussions were led by Sandage and Ryle. (W.D.M.)

13084 GAMMA-RAY ASTRONOMY. Fichtel, Carl E. (Goddard Space Flight Center, Greenbelt, Md.). Sky Telesc., 35: 85-8(Feb. 1968).

The processes taking place in galactic and extragalactic space which give rise to high-energy gamma rays are discussed. The various detecting instruments including the optical chamber, vidicon system, sonic chamber, and magnetic-core digitized spark chamber are discussed, and their advantages and disadvantages are considered. (W.D.M.)

13085 THE MAGNETIC FIELD OF A CONTRACTING GAS CLOUD. II. FINITE DIFFUSION EFFECTS: AN ILLUSTRATIVE EXAMPLE. Mestel, L.; Strittmatter, P. A. Mon. Notic. Roy. Astron. Soc., 137: 95-105(1967).

The effect of Ohmic diffusion on the magnetic field distribution derived in Paper I, Mon. Notic. Roy. Astron. Soc., 133: 265(1966), is studied by means of a numerical example, in order to demonstrate how the detachment of magnetic field lines, through a central condensation, from those of the background medium, follows when the assumption of strict flux freezing in an ionized gas is relaxed. (auth)(UK)

13086 RADIO OBSERVATIONS OF TWO SUPERNOVA REMNANTS. Caswell, J. L. Mon. Notic. Roy. Astron. Soc., 136: 11-18(1967).

The radio sources CTAI and HB_3 were observed recently at the Mullard Radio Astronomy Observatory at relatively low frequencies. In addition to providing more accurate estimates of the spectral indices of the sources, the data are of particular interest since they are of higher resolution than previous observations and therefore show details of the structure of the sources. (auth)(UK)

13087 ENERGY CONTENT OF A WHITE DWARF AND ITS RATE OF COOLING. Mestel, L.; Ruderman, M. A. Mon. Notic. Roy. Astron. Soc., 136: 27-38(1967).

It is known that in a zero-temperature "black dwarf" star the ions arrange themselves in a nearly rigid lattice structure, with the associated Coulomb energy reducing the total energy somewhat below that of the Chandrasekhar model. In a white dwarf of moderate internal temperature the lattice structure is preserved, and besides the zero-point oscillation energy of the lattice there is a thermal oscillation energy, partly kinetic and partly Coulomb. At higher temperatures the lattice begins to melt, but since the melting takes place at nearly constant volume, there should be no discontinuous change in the specific heat. Over the whole temperature range of interest for most white dwarfs it is probably correct to use the Dulong–Petit specific heat; only at temperatures high enough for vaporization will the ionic specific heat become that appropriate to a classical gas. As the star cools and contracts slightly, gravitational energy is released comparable to the change in the thermal energy; almost all of this, however, is absorbed by the increase in exclusion energy accompanying the density increase, so that it is semantically correct to speak of a white dwarf as radiating at the expense of its thermal energy. Because of the Coulomb contribution to the thermal energy, the computed lifetimes are twice earlier estimates. (auth) (UK)

13088 ALPHA PARTICLE CAPTURE REACTIONS IN LIGHT ELEMENTS AT VERY HIGH STELLAR TEMPERATURES. Wiedling, T. (Aktiebolaget Atomenergi, Studsvik, Sweden). Ark. Fys., 34: 467-80(1967).

Alpha capture reactions in light elements play a dominant role in the development of stars and in synthesis of light elements. Recent nuclear reaction data have made it possible to calculate new reaction rates and energy production rates of the three particle alpha capture process as well as alpha capture by ^{12}C and ^{16}O. The calculations are mainly concentrated to temperatures between 1 and 5×10^{9}°K, which are expected to exist in the core of supernovae. Type-I supernovae were studied in a state after the expansion when the core is developing from a hot helium–neutron phase to a state when the helium nuclei are leaving this state and conditions for helium reactions exist at high temperatures. (auth) (Sweden)

13089 ONE-DAY SUNSPOTS AND MINNAERT'S DIAGRAM. Pajdusakova, L. Bull. Astron. Inst. Czech., 18: 313-19(1967).

The Greenwich (1933 to 1958) and Zürich (1938 to 1963) materials show differences in the dependence of the occurrence of one-day spots upon the distance from the central meridian. These differences may be explained by the differing observational methods (visual vs photographic method), the differing resolving power of the instruments used, and by the fact that the one-day spots observed are of two types, that is true one-day spots and apparent one-day spots. In the Zürich material, the west half prevails over the east half in the number of one-day spots for the central region of the solar disc, while the Greenwich material has a negative (E–W) asymmetry. The limb regions give a negative asymmetry for both stations in that the number of one-day spots observed on the west limb of the solar disc is larger than on the east limb. This negative asymmetry applies mainly to apparent one-day spots. It may be explained from Minnaert's diagram by the unequal development of spots in their initial and final stage, and by the rotation of the Sun. (auth)

13090 NOTES ON THE METALLIC LINE EMISSION IN SOLAR FLARES. Banin, V. G.; Kopecky, M.; Rybina, A. A. (Siberian Inst. of Terrestrial Magnetism, Ionosphere, and Radiowave Propagation, Irkutsk, USSR). Bull. Astron. Inst. Czech., 18: 319-24(1967).

The visibility effect of Fraunhofer lines through the emission core is examined as underlying the splitting of the metallic emission in certain solar flares. In this case, the temperature of 4300 to 5000°, obtained from the characteristics of the line splitting, refers to the upper layers of the photosphere of which this very same value is characteristic. Discussed is the emission-narrowness effect which consists in the fact that certain emission cores are markedly narrower than the corresponding Fraunhofer lines. The emission need not be contracted all along its length, and is then wedge-shaped or triangular. The emission narrowness is most likely connected with the disintegration of the external layers of the flare where the turbulent motions may be more enhanced than those in the central part. Confirmed from new material is the dependence of the rate of the metal-line brightening on the excitation potential, as determined by Banin (1964). It is shown that high intensity is reached first by Fe(II) lines, followed by Fe(I) lines and then only by the lines of other elements. (auth)

13091 TIME–LATITUDE OCCURRENCE OF FLARES IN TWO ACTIVITY CYCLES. Krivsky, L. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov); Knoska, S. Bull. Astron. Inst. Czech., 18: 325-8(1967).

Given is the time–latitude occurrence of flares in the two latest cycles of solar activity between 1944 and 1965. It is seen from isoline charts that the flare activity largely varies in the occurrence of flares. There are indications of an occurrence of "flare impulses" of activity in the form of cores (maxima) which are 2.5 to 3 years apart. For the cycle 1945–1954, the occurrence of frequency cores in the north and south was almost simultaneous and symmetrical, while the second cycle, that from 1954 to 1964, showed variations and asymmetry towards the equator. Also examined is the total flare activity of these cycles by curves of the

number of flares separately for small and medium flares, and separately for the largest flares, with distribution according to the occurrence on the north and south disc. (auth)

13092 NEW ELEMENTS OF ECLIPSING VARIABLE V 505 SAGITTARII. Horak, T. (Military Academy, Brno). Bull. Astron. Inst. Czech., 18: 331-3(1967).

The elements of the semi-detached system V 505 Sgr were computed under the sphere–ellipsoid assumption. Some details of this procedure are presented. The difference between the dimensions of the system in different colors is reduced to the difference in the length of the semi-major axis of the distorted secondary component, similarly as in other close binary systems. (auth)

13093 PROPERTIES OF THE ALGOL-LIKE CLOSE BINARIES. I. PRIMARY COMPONENTS IN DOUBLE-LINE BINARIES. Plavec, M. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 18: 334-46(1967).

The purpose of this series of papers is to survey the properties of the Algol-like eclipsing binaries. The first article deals with systems in which the masses and absolute dimensions can be determined directly, because the radial velocity curves of both components are available. It is shown that the primary components of all these 21 binaries are all normal main-sequence stars. No significant deviation has been found from the standard relations mass–spectral type and mass–luminosity, as defined by the main-sequence components of visual binaries and detached eclipsing binaries. A normal mass of the primary is established also in three systems (DN Ori, XZ Sgr, and λ Tau), in which large deviations were indicated by older observations. The mass–spectral type relation for the primaries can be applied to determining masses and absolute dimensions for systems with only one spectrum measurable. This condition determines, however, a certain range of admissible masses rather than a single fixed value. Under certain conditions, the mass–spectral type relation can be supplemented and the range of admissible masses narrowed by applying the condition following from the existence of the critical Roche limit. This problem will be studied in a separate article. The existence of one or more separate subgroups among the Algol-like systems is indicated. Quite well-established is the subgroup of which AR Lac can be prototype; the character of these binaries suggests that they may be fundamentally different from the genuine Algol binaries. (auth)

13094 MICROWAVE BACKGROUND IN A STEADY-STATE UNIVERSE. Shakeshaft, J. R.; Webster, A. S. (Cavendish Lab., Cambridge, Eng.). Nature (London), 217: 339-40(Jan. 27, 1968).

It is widely believed that the microwave background radiation had its origin in a hot early phase of an expanding Universe, but the possibility has recently been considered that it is a result of the thermalization of starlight by interstellar dust grains. It is claimed that this could explain the fact that the energy density of the 3°K radiation is very close to that of starlight, magnetic fields, turbulent gas motions, and cosmic rays, all measured in the galactic disk, and also the energy produced by the conversion from hydrogen to helium of one-third the mean density of visible galaxies—a fraction which corresponds to the ratio of helium to hydrogen in young stars. A recent paper by Zeldovic and Novikov has considered and discounted this possibility; the purpose of the present communication is to draw attention to some difficulties associated with the possibility. It is concluded that radiation from dust grains is not a satisfactory alternative to primordial origin of the cosmic microwave radiation. (UK)

13095 FORMATION AND CHEMICAL PUMPING OF OH MOLECULES. Solomon, P. M. (Columbia Univ., New York). Nature (London), 217: 334-6(Jan. 27, 1968).

It has been suggested that maser amplification may be the cause of intense OH lines observed in some small radio sources. An efficient two-body pre-association of hydrogen and oxygen may lead to the formation of OH and the population inversion needed for maser amplification. (auth) (UK)

13096 DIRECTED EMISSION MODEL FOR QUASARS. Porter, N. A. (Univ. Coll., Dublin). Nature (London), 217: 329-31 (Jan. 27, 1968).

It is argued that the difficulties of accounting for the powerful emission of energy from quasars can be resolved if the emission is assumed to be concentrated in one direction. (auth) (UK)

13097 EXTRAGALACTIC SOFT X-RAY ASTRONOMY. Rees, M. J.; Sciama, D. W. (Cambridge Univ., Eng.). Nature (London), 217: 325-9(Jan. 27, 1968).

The opacity of the galaxy to soft x rays may be less than previously supposed. This may permit a variety of extragalactic objects to be observed at ~50 Å. Some implications of this situation are discussed. (auth) (UK)

13098 ALFVEN'S CRITICAL VELOCITY HYPOTHESIS. Sherman, J. C. (Oxford Univ.). Nature (London), 217: 341-2(Jan. 27, 1968).

In his theory on the origin of the solar system Alfvén makes the assumption that when there is a relative velocity between a plasma and a neutral gas in the presence of a magnetic field, a strong ionization process is set up when the relative velocity reaches a critical value U_{crit} such that $\frac{1}{2}m_g U_{crit}^2 = eV_i$, where m_g and V_i are the mass and the ionization potential of the gas atom, respectively. Using this assumption Alfvén was able to predict fairly accurately the mass distribution of the planets and satellites in the solar system. Study of the ionization mechanism, however, leads to some difficulties. The threshold energy for ionization in a collision between a gas atom and an ion of the same gas is 2 eV; also, the ionization cross section of ions is very small compared with that of electrons, except at very high energies. The purpose of the present communication is to indicate three simple ionization mechanisms which lend support to the critical velocity hypothesis. It is suggested that the critical velocity hypothesis is a consequence of the fact that the ionization frequencies of the electrons, ions, and atoms formed in charge exchange collisions all become appreciable and increase rapidly with U near U_{crit}. The details of Alfvén's theory might have to be modified to take account of the possible effects of the ionization caused by the ions and atoms formed by charge exchange. (UK)

13099 3C 390.3, A SECOND VARIABLE N-GALAXY. Cannon, R. D.; Penston, M. V.; Penston, M. J. (Royal Greenwich Observatory, Hailsham, Eng.). Nature (London), 217: 340-1 (Jan. 27, 1968).

It had been shown that the N-type galaxy 3C 371 is variable. The present communication reports the discovery that the similar system 3C 390.3 has been varying by up to about 1.5^m during the past 70 years. This is interpreted as indicating that at least some quasars are cosmological. Relations between these N galaxies and quasars are discussed. It may be that quasars comprise more than one type of object, so that whether the red shifts of all quasars are cosmological is an open question. (UK)

13100 COMETS IN THE SOLAR WIND. III. Ioffe, Z. M. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 668-71(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 835-9(July-Aug. 1967).

The motion of the ion component of a comet atmosphere is calculated on the basis of hydrodynamic equations. The comet nucleus is regarded as a source embedded in a hypersonic flow of plasma from the Sun. If the comet plasma density ρ_w = const, the outline of the plasma head near the stopping point is described by the curve $r = a \csc(\theta/2)$, where a is the distance from the nucleus to the stopping point. The pressure at the interface between the source and the stream as well as the shape and position of the receding shock wave are determined by the method of integral relations. The ratio of the distance a to the asymptotic tail width l is found to be $l/a \approx 12$. For typical solar-wind and comet parameters the value of a is estimated as $a \approx 0.4 \times 10^{11}$ cm. (auth)

13101 TABLES OF THE SATURATION FUNCTION $\Psi(\alpha,y)$. Oliinyk, P. A.; Babii, B. T.; Sakhman, A. T. (Lvov State Univ.). Sov. Astron. AJ (Engl. Transl.), 11: 648-52(Jan.–Feb. 1968).

Translated from Astron. Zh., 44: 810-15(July–Aug. 1967).

Numerical values of the saturation function $\Psi(\alpha,y)$ are tabulated for arguments in the ranges $0 \le \alpha \le 1$ and $-7 \le \log y \le 6$, as obtained with an electronic computer from recent tables of the Voigt function. (auth)

13102 METAGALACTIC RADIO BACKGROUND IN EVOLVING MODEL UNIVERSES. Vaisberg, V. V. (Inst. of Radiophysics and Electronics, Kiev). Sov. Astron. AJ (Engl. Transl.), 11: 644-7 (Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 805-9(July-Aug. 1967).

For an evolving model of a homogeneous and isotropic Universe, the intensity of the metagalactic radio background is found as a function of the mass density ρ_0 at the present time, for all values of $0 \le \rho_0 < \infty$. If the Hubble constant is known then in effect one has a formula for the background intensity as a function of the space curvature. Requirements for radio telescopes are determined, the satisfaction of which will permit the determination of the sign of the curvature of space. (auth)

13103 ABSOLUTE AND CONVECTIVE INSTABILITY IN GRAVITATING SYSTEMS. Maksumov, M. N. (Astrophysical Inst., Dushanbe, USSR). Sov. Astron. AJ (Engl. Transl.), 11: 639-43(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 798-804(July-Aug. 1967).

A discussion is given of the problem of absolute and convective instability in a continuous gravitating medium (the interstellar gas) and in collisionless gravitating systems (stellar systems). In particular, the instability is absolute against small-amplitude disturbances in stellar systems whose stars have a symmetric velocity distribution function. The instability of such systems is therefore local: a small disturbance will grow but will remain localized in the region where it originated, a process which has governed the character of evolution in the Galaxy. (auth)

13104 FREQUENCY DISTRIBUTION OF STELLAR OSCILLATIONS. Vandakurov, Yu. V. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Astron. AJ (Engl. Transl.), 11: 630-8(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 786-97(July-Aug. 1967).

The frequency distribution of adiabatic natural oscillations of a nonuniform gravitating gas sphere is investigated. Asymptotic formulas are derived for the periods of oscillations having a large number of nodes along the radius. The frequencies are evaluated numerically for a polytropic configuration. These data are used to analyze the circumstances of resonance excitation of nonradial oscillations in a radially pulsating star, assuming that its structure is polytropic. The conditions are highly favorable for excitation if there is a large central concentration of material but the probability of instability decreases sharply if the polytropic index n falls below a certain value (≈1.8 for a star consisting of monatomic gas, with small radiation). In this range of n a resonance can arise under certain conditions, resulting in the development of two oscillations with similar frequencies. The analysis supports the hypothesis that the density distribution in Cepheids does not differ substantially from a polytrope with n ≈ 1.5. (auth)

13105 MEASUREMENTS OF THE COSMIC-RAY NUCLEI OF THE SOLAR-ACTIVITY MINIMUM OF 1964–1965. Kurnosova, L. V.; Razorenov, L. A.; Suslov, A. A.; Syrovatskii, S. I.; Fradkin, M. I. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 624-9(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 778-85(July-Aug. 1967).

Several cases of an increase in the flux of various groups of nuclei apparently connected with their generation on the Sun are described. It is pointed out that the heavier nuclei exhibit a larger relative increase. Because of this, a hypothesis is put forward that there is an acceleration mechanism on the Sun which preferentially accelerates the heavier nuclei. A quantitative description of the observed cases of increases in the fluxes of heavy nuclei is proposed which is based on the dependence of the flux of accelerated ions on their mass. (auth)

13106 NEUTRINO ENERGY RADIATION IN THE β INTERACTION OF ELECTRONS AND POSITRONS WITH NUCLEI. Imshennik, V. S.; Nadezhin, D. K.; Pinaev, V. S. Sov. Astron. AJ (Engl. Transl.), 11: 617-23(Jan.–Feb. 1968).

Energy losses by neutrino emission in β processes (electron and positron capture, β decay) taking place in an arbitrary mixture of nuclei is considered in the present paper. Numerical results were obtained for the case of free nucleons. When the density of matter in a star is $\rho \geq 10^8$ to 10^9 g/cm^3, the neutrino radiation from nucleon β processes exceeds the energy emitted in electron–positron pair annihilation. The conditions under which it is necessary to take account of the neutrino radiation of β processes can appear during the last stages of evolution of massive stars, gravitational collapse, and supernova explosions. (auth)

13107 HIGH-CONDENSATION SHOCK WAVES IN A GAS-DUST MEDIUM. Gidalevich, E. Ya. (Astrophysical Inst., Alma-Ata, USSR). Sov. Astron. AJ (Engl. Transl.), 11: 614-16(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 764-7(July-Aug. 1967).

The influence of inelastic collisions of gas atoms with dust particles on the distribution of parameters behind the front of a shock wave is considered in the present paper. Under the usual conditions obtaining in the interstellar medium, the dust concentration is too low for a significant cooling of gas by dust particles to take place. However, in the case of high-condensation shock waves, in which the concentration of dust increases strongly with distance away from the front, inelastic collisions of gas atoms with dust particles lead to considerable cooling of the gas and, consequently, to a strong increase in the density of gas and dust. It is noted that the increase in the dust concentration plays an important part in the evolution of gravitationally linked formations. (auth)

13108 SPECTROPHOTOMETRY OF NOVA HERCULIS 1960. Savel'eva, M. V. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 576-84(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 716-27(July-Aug. 1967).

The results are reported of a spectrophotometric study of Nova Herculis 1960 in the wavelength range 6560 to 3530 Å, covering the period March 11 to April 28, 1960. The dispersion of the spectrograms is 190 Å/mm at Hγ. Equivalent widths and central intensities are determined relative to the continuum for many emission lines identified in the nova spectrum. The time variation of these quantities is established. The relative energy distribution in the nova continuum is derived, and the spectrophotometric temperature of the nova is estimated. For certain dates of observation the absolute energy distribution in the nova continuum is determined in units of ergs · cm^{-2} · sec^{-1}. The Balmer decrement is evaluated from the hydrogen lines. (auth)

13109 THE NUCLEUS OF THE SEYFERT GALAXY NGC 5548. Dibai, E. A.; Esipov, V. F.; Pronik, V. I. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 553-6(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 689-92(July-Aug. 1967).

Spectra of 64- and 470-A/mm dispersion were used to analyze the physical conditions in the nucleus of the galaxy NGC 5548. The profiles of the hydrogen lines and [O III] λ 4959 were studied in detail. The electron concentration $n_e \approx 3 \cdot 10^5$ cm^{-3} and temperature $T_e \approx 14{,}000$°K in the forbidden-line emission zone. The effective size of the zone is a few parsecs, the mass of the gas is ≈1500M⊙, and the dispersal velocity of the gas is ±450 km/sec. The mass of the central, dense H II region (≤150M⊙) was determined which has an effective diameter of several tens of parsecs and velocity dispersion ±2500 km/sec. The properties of the NGC 5548 nucleus resemble those of another Seyfert galaxy, NGC 7469. (auth)

13110 OBSERVATIONS OF A LUNAR OCCULATION OF THE CRAB NEBULA AT 3.3-cm WAVELENGTH. Matveenko, L. I.; Sorochenko, R. L. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 557-60(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 693-6(July-Aug. 1967).

A description is given of the method for and results of observations of a lunar occultation of the Crab Nebula at wavelength 3.3 cm. The center of gravity of the radio emission is displaced to the northwest of the binary star by $\Delta\alpha = -50'' \pm 20''$, $\Delta\delta = 6'' \pm 20''$. The radio-emission region does not extend beyond the region visible optically. The nebula contains no small-sized sources (<1″) that would contribute over 10% of the radio emission. (auth)

13111 RADIO EMISSION OF THE CRAB NEBULA AND JUPITER AT 77.5-GHz FREQUENCY. Kislyakov, A. G.; Lebskii, Yu. V. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 561-4(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 697-701(July-Aug. 1967).

Data are reported on the radio emission of the Crab Nebula (3C 144) and Jupiter, as secured in March–April, 1966 with the 4-m radio telescope of the Gor'kii Radiophysics Institute. Jupiter's mean brightness temperature during the period of observation was $150 \pm \frac{15}{10}$°K. The flux density of the 3C 144 radio emission was $(1.13 \pm 0.24) \cdot 10^{-23}$ W · m^{-2} · Hz^{-1}. The radio telescope was calibrated against lunar and solar radio emission. (auth)

13112 A POSSIBILITY FOR DETERMINING PLASMA PARAMETERS IN SUPERNOVA ENVELOPES. Gordon, I. M. (Inst. of Radiophysics and Electronics, Kiev). Sov. Astron. AJ (Engl. Transl.), 11: 565-6(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 702-4(July-Aug. 1967).

Proceeding from the theory of weakly turbulent plasma, it is possible to expect the changes of visible angular dimensions of a central detail of supernovae of Cas A type-II with the frequency variation. The determination of the dependence of the angular dimensions of the central detail on the frequency, if the shell mass is estimated from x-ray fluxes, allows one to determine the essential parameters of the turbulent state of cosmic plasma. An analogous possibility is afforded by measurements of the thermal x rays from nucleus–halo-type sources. (auth)

13113 DETECTION OF THE Fe X 6374 A LINE IN THE SPECTRUM OF THE NEBULA NGC 6960. Shcheglov, P. V. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 567-9(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 705-7(July-Aug. 1967).

Etalon observations detected a weak (Fe X) 6374 Å line in the spectrum of NGC 6960. (auth)

13114 PHASE DEPENDENCE OF THE COLORS OF TYPE I AND II SUPERNOVAE. Pskovskii, Yu. P. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 570-5(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 708-15(July-Aug. 1967).

Composite relations are derived between the normal $(B-V)_0$ and $(U-B)_0$ color indices of type-I supernovae and their brightness phase t. The $[(B-V)_0, t]$ relation is also investigated for type-II supernovae, and its general form is established. The color–phase relations differ sharply for type-I and -II supernovae. (auth)

13115 BEHAVIOR OF THE Ca II K LINE IN THE SPECTRUM OF ALGOL. Val'tts, I. E.; Glushneva, I. N. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 585-7(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 728-31(July-Aug. 1967).

The behavior of the Ca II K line in the spectrum of the eclipsing variable system β Per is investigated from measurements of 195 spectrograms obtained at the Shternberg Institute's high-altitude field station near Alma-Ata. The equivalent width of the K line is evaluated for various phases of eclipse; it is 2.4 times as great at primary minimum as at other phases. This result agrees qualitatively with other authors' findings, and confirms the theoretical estimate for the ratio inferred from the assumption that the dark companion is a type K0 star. A doubling is observed in the K line on three spectrograms taken at primary minimum. (auth)

13116 TWO DECAY PROCESSES FOR CO MOLECULES IN THE SOLAR PHOTOSPHERE. Sitnik, G. F.; Pande, M. Ch. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 588-91(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 732-6(July-Aug. 1967).

Two processes are considered for the dissociation of CO molecules in the transition layer between the solar photosphere and chromosphere, and the dissociation rates are computed. Photodissociation by electronic transition is found to be somewhat stronger than the dissociation of CO through collisions with hydrogen atoms. The chemical relaxation time for the photodissociation process is about 2700 sec, long enough for a Maxwell–Boltzmann distribution of the reacting CO molecules over their states to be established. (auth)

13117 ABSOLUTE SPECTRAL ENERGY DISTRIBUTION FOR 18 TYPE B5–M2 STARS. Kharitonov, A. V.; Knyazeva, L. N. (Astrophysical Inst., Alma-Ata, USSR). Sov. Astron. AJ (Engl. Transl.), 11: 598-601(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 745-9(July-Aug. 1967).

For 18 stars of various spectral types from B5 to M2, the absolute spectral energy distribution is derived—the monochromatic illuminance produced by the stars outside the atmosphere, expressed as 10^{-9} ergs/cm^2 · sec (100 A). For three early-type stars the values refer to the continuum, and for the others (type G and later), to the integrated spectrum, that is, the continuum plus the lines and absorption bands. The integrated spectrum is approximated by a histogram. (auth)

13118 STATISTICAL IDENTIFICATION OF STELLAR ASSOCIATIONS OF VARIOUS SPECTRAL TYPES: A FIELD IN CENTAURUS. Loden, Lars Olof (Stockholm Observatory). Sov. Astron. AJ (Engl. Transl.), 11: 602-6(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 750-4(July-Aug. 1967).

A statistical method is applied for testing whether various groups of stars in a certain field in Centaurus combine to form associations. The preliminary results encourage further studies of the validity of the method. (auth)

13119 PHOTOELECTRIC OBSERVATIONS OF THE POLARIZATION AND COLOR OF THE REFLECTION NEBULA NEAR MEROPE. Artamonov, B. P.; Efimov, Yu. S. (Shternberg State Astronomical Inst., USSR. Crimean Astrophysical Observatory, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 607-8 (Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 755-6(July-Aug. 1967).

Photoelectric measurements are reported of changes in polarization and color of the reflection nebula near Merope with distance from the star. There is a systematic correlation between the direction of the magnetic field and the direction of filaments in the nebula on the one hand, and the distance from the star on the other. It is probable that this tendency is a reflection of a definite structure of the local magnetic field in the nebula. (auth)

13120 BINARY SYSTEM AS A QUASAR MODEL. Komberg, B. V. Sov. Astron. AJ (Engl. Transl.), 11: 727-8(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 906-7(July-Aug. 1967).

A possible binary nature for the nuclei of certain quasars is suggested by various observational evidence. (auth)

13121 INTERPRETATION OF THE EXCESS INFRARED EMISSION OF NONSTATIONARY STARS. Kolesnik, I. G.; Frank-Kamenetskii, D. A. (Central Astronomical Observatory, Kiev). Sov. Astron. AJ (Engl. Transl.), 11: 726(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 905-6(July-Aug. 1967).

The excess infrared emission of nonstationary stars supports the author's earlier hypothesis that the radiation is nonequilibrium in character. (auth)

13122 FRACTIONATION OF IRON IN THE SOLAR SYSTEM. Tozer, D. C. (Univ. of Newcastle upon Tyne, Eng.). Nature (London), 217: 437(Feb. 3, 1968).

A reply is given to the communication of Banerjee (Nature 216: 781(1967)) which argues against the influence of ferromagnetism on the aggregation of particulate matter in a theory by the present author on chemical fractionation within the solar system (Nature 215: 1449(1967)). Banerjee's objection is based on one of the more unsatisfactory parts of magnetic theory—the prediction of spin structure. (UK)

13123 PRODUCTION OF OH MOLECULES IN INTERSTELLAR SHOCK WAVES. Field, G. B. (Univ. of California, Berkeley); Aannestad, P. A.; Solomon, P. M. Nature (London), 217: 435-7(Feb. 3, 1968).

Measurements have shown that there is interstellar OH absorption in most low-latitude radio sources. Earlier work on the production of OH is briefly reviewed. The present authors have calculated the OH production caused by pre-association, thus: O + H → OH ($K_1 = 3 \times 10^{-15} \exp(-3{,}700/T)$ cm^3 sec^{-1}, where $K_1 = \dot{n}$ (OH)/n(O)n(H)). This reaction requires the high temperatures behind shock waves. Component and other reaction processes are discussed, and their contributions assessed. In their work the authors used a grid of temperature density profiles depending on Mach number, initial H_2 abundance, and pre-shock magnetic field strength. The OH production for Mach 10 is shown graphically. Although it seems likely that interstellar hydrogen abundance is very low, calculations were made for H_2/H. Photodissociation of H_2 was ignored. A magnetic field changes cooling times, and hence molecular production. A mean value of 2×10^{-10} was obtained for OH/H, about 100 times the amount caused by chemical exchange on interstellar grains, but still 200 times smaller than the observed value, so that the above reaction cannot be solely responsible for the observed OH. The possibility arises that in the immediate vicinity of shock fronts production of hydrogen on grains is so rapid that a considerable hydrogen abundance builds up. (UK)

13124 SMALL-SCALE DISTRIBUTION OF INTERSTELLAR ABSORPTION. Ishida, K.; Akabane, K. (Tokyo Univ.). Nature (London), 217: 433-5(Feb. 3, 1968).

A survey programme of Hα photographs of galactic emission nebulae has been in progress since Oct. 1966, using a 50 cm. Schmidt telescope, and seven galactic H II regions (IC 1795, IC 1805, M 20, M 8, M 16, M 17, and NGC 7000) have so far been analyzed. The photographs are converted to isophotal contour maps using an iso-densitometer. Comparison of these contour maps with those of microwave radio emission is of interest. Both maps represent the emission measure, but the former include interstellar absorption of solid grains. The comparison enables the making of a map of the interstellar absorption, assuming that both radiations are thermal. A comparison is illustrated for a complex region near the galactic equator; small-scale structure of absorption is clearly seen, as well as the general tendency towards heavier absorption in lower galactic latitude. The absorption is chiefly that within the H II region, but also includes a contribution from the space between the Earth and the H II region. The technique described is a method for deriving an absolute absorption value, and will help to clarify the role of interstellar dust grains in the H II regions. (UK)

13125 CONDENSATION OF THE PLANETS. Hoyle, F.; Wickramasinghe, N. C. (Cambridge Univ., Eng.). Nature (London), 217: 415-18(Feb. 3, 1968).

The implication that the early overluminous phase, during the condensation of the Sun, can be a great help in understanding why the inner planets are largely made up of iron and magnesium silicate, is reviewed. (auth) (UK)

13126 ORIGIN OF THE DIFFUSE INTERSTELLAR BANDS. Wickramasinghe, N. C. (Cambridge Univ., Eng.); Ireland, J. G.; Nandy, K.; Seddon, H.; Wolstencroft, R. D. Nature (London), 217: 412-15(Feb. 3, 1968).

Unidentified diffuse interstellar bands may be caused by electronic transitions of impurity ions in grains which are coupled to the lattice vibrations. The 4430 absorption band has a significantly asymmetric profile, being somewhat steeper on the red side than on the blue. This feature is taken into account in a solid-state model proposed for the band. (auth) (UK)

13127 HALF LIFE OF THE NEUTRON AND COSMOLOGICAL HELIUM PRODUCTION. Taylor, R. J. (Univ. of Sussex, Eng.). Nature (London), 217: 433(Feb. 3, 1968).

New measurements of the neutron half life have given the significantly lower value of 10.8 min. (as compared with the previous value of 11.7 min.), and this implies an increase in cross sections for the reactions $n + e^+ \rightleftharpoons p + \bar{\nu}$ and $p + e^- \rightleftharpoons n + \nu$, so that the

neutron number remains closer to that predicted by thermal equilibrium. There are fewer neutrons when He production occurs, hence the amount of He produced is reduced. Calculations of helium production in the early stages of a Friedmann universe have given values between 25 and 30% by mass; it appears, however, that if the new value of the neutron half life is accepted, these values should be reduced to about 23 and 27.5%. Such a reduction is in the correct direction if the cosmological theory is to be correct. It is known that He can be produced astrophysically, but there is at present no belief that large scale destruction of He has occurred in the Universe, and thus all observed He abundances should exceed that produced cosmologically. The reduction in the predicted cosmological He abundance might prove significant in a detailed comparison between theory and observation. (UK)

13128 RARE GASES IN STONY METEORITES. Zaehringer, J. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Geochim. Cosmochim. Acta, 32: 209-37(Feb. 1968).

The contents and isotopic composition of He, Ne, and Ar in 81 stony meteorites were determined. The ^{3}He exposure ages, and the radiogenic ^{4}He and K–Ar ages, confirm the conclusions of previous publications. The exposure ages of diogenites are clustered around 20×10^6 yr. The H-chondrites Benoni, Cee Vee, Grassland, Heredia, Hessle, and Menow, the L-chondrite Bishunpur, and the carbonaceous chondrites Alais and Essebi, contain He and Ne as primordial components. A dark inclusion in the amphoterite Krähenberg has an extremely high K content of 12,000 ppM. The contents of ^{84}Kr and ^{132}Xe and the ^{129}Xe : ^{132}Xe ratio were also determined in 92 stony meteorites. Not only the ^{84}Kr and ^{132}Xe contents, but also the content of the ^{129}Xe excess, are proportional to the primordial ^{36}Ar content over a larger range. The primordial ^{36}Ar contents are related to the petrological classes of Van Schmus and Wood. The ^{129}Xe : ^{132}Xe ratios of all ordinary chondrites lie between 1 and 3, and all enstatite chondrites have ratios between 3 and 7. If it is assumed that the I–^{129}Xe relation from the work by Reynolds and co-workers is valid, it must be concluded that all ordinary chondrites had initially about the same Xe : I ratio, and that most of them lost a large fraction of their primordial rare gases after the ^{129}I decay, while the high-temperature fraction retained all of the ^{129}Xe. This imposes quite narrow constraints on the model for I–^{129}Xe dating. (UK)

13129 SOME GENERAL PROBLEMS OF THE STUDY OF RECOMBINATION SPECTRA IN ASTROPHYSICS. I. Nikitin, A. A. Uch. Zap. Leningrad. Gos. Univ., No. 334, Ser. Mat. Nauk, No. 41, 3-13(1967). (In Russian).

Some peculiarities in the recombination spectra of complex atoms are investigated. The different forms of vector couplings are considered from astrophysical point of view. (auth)

13130 THICKNESS OF DUST NEBULAE. Kolesov, A. K. Uch. Zap. Leningrad. Gos. Univ., No. 334, Ser. Mat. Nauk, No. 41, 14-20(1967). (In Russian).

The emergent light flux from a homogeneous spherical dust nebula with a star in its center is found. The ratio D of nebula brightness to star brightness is computed as function of values τ_0, k, x_1. By means of comparison of theoretical values of D with the observed ones, some conclusions on the value of optical thickness τ_0 of the dust nebulae are drawn. (auth)

13131 DETECTING OF THE EXTENDED SKY OBJECTS OF SMALL SURFACE BRIGHTNESS BY MEANS OF PHOTOGRAPHICAL OBSERVATIONS. Dombrovskii, V. A. Uch. Zap. Leningrad. Gos. Univ., No. 334, Ser. Mat. Nauk, No. 41, 21-37(1967). (In Russian).

The limitation in detecting the extended sky objects of small surface brightness by using the photographic method are considered. The problem is that of detecting a small contrast on the background of noises of a photoplate struck by the light of the night sky. The photoplate noises to plate gradient ratio is of high importance. The plate noises are analyzed as well as the means of reducing them. The possibilities of strengthening the contrast — the observed object vs. the sky background — by choosing the appropriate conditions of observations are also investigated. The most favorable spectral region to observe the extragalactic nebulae is determined. (auth)

13132 POLARIZATION OBSERVATIONS OF CLOSE BINARY STARS. Shulov, O. S. Uch. Zap. Leningrad. Gos. Univ., No. 334, Ser. Mat. Nauk, No. 41, 38-53(1967). (In Russian).

The results of 767 photoelectric polarization observations for 14 close binary stars are described. It is ascertained that the polarization parameters of the eclipsing systems RY Per, β Lyr, V 444 Cyg, U Sge, and Z Vul are variable. (auth)

13133 POLARIZATION STUDY OF THE GALAXY NGC 3077. Hagen-Thorn, V. A. Uch. Zap. Leningrad. Gos. Univ., No. 334, Ser. Mat. Nauk, No. 41, 54-9(1967). (In Russian).

The method of polarimetric observations of the galaxies is described. The results of the photographic and photoelectric observations are given for the galaxy NGC 3077. (auth)

13134 COMPARATIVE STUDY OF THE HYDROGEN LINES IN SPECTRA OF FACULAE AND OF NONDISTURBED PHOTOSPHERE. Voikhanskaya, N. F. Uch. Zap. Leningrad. Gos. Univ., No. 334, Ser. Mat. Nauk, No. 41, 73-82(1967). (In Russian).

Comparative analysis of the first four lines of Balmer series in the spectra of faculae and of adjoining region of the photosphere is carried out. The mean electron concentrations are determined. There is some difference between $(n_e)_{fac}$ and $(n_e)_{ph}$. The quantity $\Delta T_e = (T_e)_{fac} - (T_e)_{ph}$ is evaluated. The excitation mechanisms for the second state of the hydrogen atom are briefly discussed. (auth)

13135 METHOD OF DIRECT ABSOLUTE MEASUREMENTS OF TOTAL SOLAR RADIO FLUX DENSITY. Nagnibeda, V. G. Uch. Zap. Leningrad. Gos. Univ., No. 334, Ser. Mat. Nauk, No. 41, 105-12(1967). (In Russian).

Absolute measurements of the solar radiation in cm wavelengths were made, using the external standard "artificial Sun," which is a high-brightness temperature source. The "artificial Sun" is placed behind a screen with a hole; the screen is mounted in the Fraunhofer zone of the aerial, and the size of the hole is equal to the Sun space angle. The "artificial Sun" radiation is compared with the radiation from the zenith which is also measured through this hole using a mirror. (auth)

13136 MASSES OF STARS IN GLOBULAR CLUSTER M3. Petrovskaya, I. V. Uch. Zap. Leningrad. Gos. Univ., No. 334, Ser. Mat. Nauk, No. 41, 113-16(1967). (In Russian).

An attempt to estimate the masses of the stars of different magnitudes in the globular cluster M3 was made, using Sandage star counts. The basic assumption is that the outer regions of the cluster may be described with the aid of the model having a quasi-stationary nucleus. (auth)

13137 LUMINOSITY FUNCTION OF FIELD GALAXIES WITH ALLOWANCE FOR OBSERVATIONAL SELECTION. Nezhinskii, E. M.; Osipkov, L. P. Uch. Zap. Leningrad. Gos. Univ., No. 334, Ser. Mat. Nauk, No. 41, 117-26(1967). (In Russian).

Two luminosity functions for 390 galaxies with known apparent magnitudes m_{pg} and radial velocities v are derived: (1) for galaxies with 1000 km/sec < v < 3500 km/sec, and (2) for galaxies with v < 3500 km/sec. The luminosity functions for elliptical galaxies, spirals, and barred spirals are constructed separately as well as for Sa, Sb, and Sc galaxies. Important differences of these functions were not found. (auth)

13138 MERIDIAN RADIOINTERFEROMETER WITH RADIOELECTRIC CONNECTIONS. TECHNIQUES AND OBSERVATIONS. Laffineur, M.; Coupiac, P. (Institut d'Astrophysique, Paris). Bull. Soc. Roy. Sci. Liege, 36: 393-417(1967). (In French).

A two-element radio interferometer is described. The two elements are large cylindro-parabolic antenna. These antenna, the Hertzian cables, and the interferometer are described in some detail. Typical measurements made to verify the operation of the various components are described. A description is given of the observational techniques used. The observation of radiosources of the 3C and 3C′ catalogues made since 1959 when the installation was put into use are tabulated. The results indicate that two-element interferometers could become the best instrument for the study of pulsed radiosources such as quasars. (J.S.R.)

13139 NONRADIAL OSCILLATIONS OF MASSIVE STARS. Smeyers, P. (Univ., Liege). Bull. Soc. Roy. Sci. Liege, 36: 357-92(1967). (In French).

The nonradial oscillations of two massive star models composed of an extended convective core and of an envelope in radiative equilibrium are studied. The perturbation of the gravitation potential is not neglected. The study of the nonradial oscillations leads to a problem with eigenvalues of the fourth order. The center and the surface are singular points of the system of linear differential equations. The behavior of the general solution in the vicinity of these points is studied. Continuity conditions are then imposed on the regular solutions coming from the center and the surface. This discussion makes it possible to develop a method which will serve for the numerical determination of eigenvalues and of eigensolutions of the problem. Certain characteristics of different types of nonradial modes are deduced. The superadiabatic excess of the temperature gradient is introduced into the convective core assumed in adiabatic equilibrium. The problem of dynamic stability can thus be dealt with to some extent. (auth)

13140 PHOTOMETRIC ANALYSIS OF SOLAR FLARES. Falciani, R.; Righini, A.; Rigutti, M. (Osservatorio Astrofisico di Arcetri, Florence). Z. Astrophys., 67: 481-9(1967).

An improved photographic technique to get a fine network of isophotes within a flare and the instrumentation used for this purpose are briefly described. Evolutive curves at several intensity levels of a flare can easily be obtained. On the basis of these curves some critical remarks on the present flare classification are made. (auth)

13141 CORONA IN THE SOLAR ECLIPSE OF NOVEMBER 12, 1966. I. GENERAL PHOTOMETRY. Waldmeier, M. (Eidgenossische Sternwarte, Zurich). Z. Astrophys., 67: 463-80(1967). (In German).

The total solar eclipse of November 12, 1966 was observed near Arequipa (Peru) at an altitude of 3000 m. During totality that lasted only 62 sec, nine pictures of the corona were secured, using a camera of 225-cm focal length (f/15). The films are photometrically calibrated. The brightness of the corona for different distances and position angles is given. The brightness distribution is represented. Generally speaking, the corona is brighter in the northern than in the southern hemisphere, except in the region of the long streamers ($r > 1.4$, $|b| < 40°$), where the southern corona is the more intense. The gradient of the brightness is low at the poles and in the long streamers, large over the northern zone of activity and on the borders of the streamers. Corresponding to the strong N–S asymmetry of the solar activity the structure of the corona is very different on both hemispheres. The southern hemisphere shows a corona of the minimum type with broad and long streamers at low latitudes and with the typical polar plumes. The northern hemisphere is dominated by bright but small streamers and corresponds to an enhanced state of solar activity. The ellipticity of the isophotes is 2.7 times larger in the southern than in the northern hemisphere. (auth)

13142 PHOTOELECTRIC STUDY OF THE ULTRA SHORT PERIOD STAR SZ LYNCIS. Joshi, S. C.; Srivastava, H. N. (Uttar Pradesh State Observatory, Naini Tal, India). Z. Astrophys., 67: 456-62(1967).

The star SZ Lyn shows sudden shifts in the time of occurrence of its light maximum. The period of the star, and its light and color curves undergo changes. The radius and the mass of the star were estimated. (auth)

13143 STELLAR EVOLUTION. VIII. THE HELIUM-FLASH IN A STAR OF 1.3 SOLAR MASSES. Thomas, H.-C. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Z. Astrophys., 67: 420-55(1967). (In German).

The results of evolutionary computations for a star of 1.3 solar masses are given, starting with the chemically homogeneous main sequence model. During the core contraction phase after the central hydrogen burning has ceased, neutrino production, according to the weak interaction theory, started, leading to cooling in the central region of the star. This resulted in a helium flash, starting in a spherical shell around the center. After the helium flash there was no overall mixing, but partial mixing occurred. By this mixing the carbon content of the surface layers increased by a factor of four. When the helium flash had slowed down, a thermally unstable helium burning shell was built up. The calculations followed nearly four of the resulting thermal pulses. (auth)

13144 SCALE OF BOLOMETRIC CORRECTIONS. Weidemann, V.; Bues, I. (Institut fuer Theoretische Physik und Sternwarte, Kiel). Z. Astrophys., 67: 415-19(1967).

Bolometric corrections determined empirically or by computation are usually referred to the Sun or to other stars. B.C.'s obtained by this method are often not comparable since reference values differ according to different scales in use. In order to remove the ambiguities it is proposed to use black bodies in place of stars as standards of reference. The scale of bolometric corrections may then be fixed once and for all by postulating B.C. (minimum) = −0.1, in accordance with Kuiper's 1938 scale. (auth)

13145 FLARES OF STARS OF THE UV CETI TYPE. Gershberg, R. E. (Crimean Astrophysical Observatory, USSR). Usp. Fiz. Nauk, 92: 65-73(May 1967). (In Russian).

The present article is actually an expanded version of an original paper, and reviews the spectrographic investigations of flaring stars of the UV Ceti type. The emphasis is on photoelectric observations of the brightness of these stars, which have been going on at the Crimean Astrophysical observatory since 1960, covering approximately 50 flares. The most prominent results, namely the variation of the brillance of two of the stars (AD Leonis and UV Ceti) and their emission spectra, are presented and discussed. An analysis of these spectra shows that these stars have a rich emission spectrum in the quiescent state, and should exhibit a behavior similar to that of the Sun (they should possess a chromosphere and a corona and should be subject to strong convection currents). It can therefore be assumed that the relatively cold photosphere of these stars is surrounded by hotter transparent layers of atmosphere, and the downward energy flow gives rise to the flares. The three hypotheses concerning the mechanism producing the flares (the hypothesis of coronal condensation, the hypothesis of chromospheric flare, and the hypothesis of shock-wave emergence) are discussed in some details and arguments in their favor and against them are presented. The similarity between the activity of these stars and that of the Sun is pointed out. (ATD)

13146 LABORATORY SIMULATION OF PLASMA PHENOMENA IN COMETS. Danielsson, L. R.; Kasai, G. H. (Advanced Kinetics, Inc., Costa Mesa, Calif.). J. Geophys. Res., 73: 259-66 (Jan. 1, 1968).

A model experiment simulating the interaction between the solar wind and comets is described. The aim is to study the ionization and acceleration of molecules in the atmosphere of a comet. A phase stream ($n_e = 10^{12}$ cm^{-3}, $T_e = 3$ eV, $v = 6 \times 10^6$ cm/sec) in a vacuum tunnel interacts with a cloud of CO_2 gas sublimated from a dry ice core of 1-cm radius. The gas density at the surface o. the ice is 5×10^{13} cm^{-3}. Diagnostic methods include image converter photography and spectrography. The interaction, which is characterized as collisionless, gives rise to a well-defined tail developing to a length of 20 cm within 10 μsec after the first impact of the stream against the cloud. A visible coma extends about 3 cm in front of the ice. The CO_2 gas is found to be substantially ionized and dragged along with the stream. The ionization is believed to be explainable in terms of an increased average electron energy caused by the interaction. The drag on the ions is probably due to magnetic coupling to the plasma stream. (auth)

13147 OBSERVED ABSENCE OF ENERGETIC ELECTRONS AND PROTONS NEAR VENUS. Van Allen, J. A.; Krimigis, S. M.; Frank, L. A.; Armstrong, T. P. (Univ. of Iowa, Iowa City). J. Geophys. Res., 73: 421-5(Jan. 1, 1968).

From the results from Mariner 5 it is concluded that the environment of Venus is almost, if not completely, devoid of energetic particles associated with the planet. It is also concluded that the intrinsic magnetic dipole moment of Venus is certainly less than 0.01 and probably less than 0.001 of that of Earth and corresponding upper limits on the equatorial surface magnetic field are about 350 and 35×10^{-5} gauss. The magnetofluiddynamic interaction of the solar wind with the conducting ionosphere and/or the body of Venus is too weak to generate an observable intensity of electrons having energies exceeding 45 keV. (W.D.M.)

13148 HIGH-ENERGY X RAYS FROM THE SOLAR FLARE OF JULY 7, 1966. Cline, T. L. (Goddard Space Flight Center, Greenbelt, Md.); Holt, S. S.; Hones, E. W. Jr. J. Geophys. Res., 73: 434-7(Jan. 1, 1968).

The measurements were made over the highest differential energy range studied thus far, 80 keV to 1 MeV, during one of the first high-intensity flares of the new solar cycle, that of July 7, 1966. They indicate perhaps the greatest intensity in high-energy solar x rays of any event observed to date and appear to be much more easily reconciled to the nonthermal bremsstrahlung hypothesis. (W.D.M.)

13149 EVOLUTION OF CENTRAL STARS OF PLANETARY NEBULAE. Deinzer, W. (Lehrstuhl fuer Theoretische Astrophysik, Heidelberg). Z. Astrophys., 67: 342-69(1967). (In German).

To reach an understanding for the short evolutionary timescale of some 10^4 years for central stars of planetary nebulae, the following type of stellar models is considered: An isothermal core obeying the equation of state for partially degenerate matter and a radiative envelope containing less than a percent of the stellar mass are fitted together. Calculations were made for the following stellar models: 0.4 $M_\odot$-star with helium-core and population II-envelope; 0.5 $M_\odot$-star with carbon-core and helium-envelope. Starting with very extended envelopes, evolutionary sequences were obtained for the case that the luminosity requirements are satisfied by gravitational and internal energy release of the core; contributions from nuclear shell-sources or gravitational and internal energy release of the envelope are shown to be unimportant in these cases. The sequences are in fair agreement with the Harman–Seaton sequence; an upper limit for the evolutionary timescales is comparable with the observed one. Simplifications of the models are discussed briefly. (auth)

13150 CURVES-OF-GROWTH AND COURSE ANALYSIS OF SUNSPOTS. Ruhm, H. (Landessternwarte, Heidelberg). Z. Astrophys., 67: 370-6(1967). (In German).

With equivalent widths of 148 lines of FeI, FeII, TiI, and TiII

published by FRICKE and ELSÄSSER and absolute oscillator-strengths curves-of-growth for the photosphere and the sunspot Wilson No. 11730 were constructed. The mean values for excitation-temperature, turbulence, gas- and electron-pressure derived in a course analysis qualitatively confirm the results found by FRICKE and ELSÄSSER by the same method but using solar gf-values. (auth)

13151 ON THE PULSATION OF RR LYRAE STARS AND THE STRUCTURE OF HORIZONTAL BRANCH MODELS. Joergensen, H. E.; Petersen, J. Otzen (Copenhagen Univ. Observatory). Z. Astrophys., 67: 377-409(1967).

Hydrogen-burning models for RR Lyrae stars are studied, and it is shown that the mass must be at least 1.0 solar mass and the envelope hydrogen content close to 0.90, in order to obtain $M_V \cong 0.5$ and a life-time of the order 10^8 years. Pulsation periods of these models are derived and discussed. All models obey a period–density relation, which is applied to study the RR Lyrae stars in M 3, ω Cen, and other globular clusters, and in the field. It is shown that the masses of ab and c type variables in M 3 are equal, and absolute mass values are derived, assuming different distance moduli. Comparing data for M 3 and ω Cen a negligible mass difference is indicated. For field RR Lyrae stars the metal content is shown to be correlated with the mass and/or the luminosity, using data published by STURCH. (auth)

13152 SEARCH FOR A FREQUENCY SHIFT OF THE 21-CENTIMETER LINE FROM TAURUS A NEAR OCCULTATION BY SUN. Sadeh, D.; Knowles, S. H.; Yapler, B. S. (Naval Research Lab., Washington, D. C.). Science, 159: 307-8(Jan. 19, 1968).

The 21-centimeter absorption line from the direction of Taurus A was used for detection of a shift in frequency when the source passed near Sun. A possible decrease in frequency of 150 cycles/sec was detected, which cannot be caused by general relativity or by the plasma around Sun. (auth)

13153 EXCITATION TEMPERATURE OF THE 18-CM LINE OF OH IN H I REGIONS. Rogers, A. E. E.; Barrett, A. H. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 151: 163-75(Jan. 1968).

OH radio absorption observations have led to estimates of the OH/H abundance ratios, but such estimates have been based on an assumed excitation temperature of OH. A value of ~10°K, an order of magnitude less than for H, has often been used. In this paper the physical mechanisms which compete to establish the OH excitation temperature in a typical H I cloud are examined and transition rates evaluated. It is shown that OH-ion collisions and 18-cm radiation are the most important processes. The excitation temperature is evaluated for an H I cloud and shown to be ~30°K for a neutral hydrogen density of 10 atoms/cm^3. Observations place an upper limit of 2° to 10°K on the excitation temperature, suggesting that OH may be prevalent in H I clouds having low abundances of heavy ions. (auth)

13154 INFRARED OBSERVATIONS OF THE GALACTIC CENTER. Becklin, E. E.; Neugebauer, G. (California Inst. of Tech., Pasadena). Astrophys. J., 151: 145-61(Jan. 1968).

Infrared radiation from the nucleus of the Galaxy was detected at effective wavelengths of 1.65, 2.2, and 3.4 μ with angular resolutions from 0.″8 to 1.″8. The structure consists of: (1) a dominant source 5′ in diameter; (2) a pointlike source centered on the dominant source; (3) an extended background; and (4) additional discrete extended sources. Contour maps of the 2.2-μ brightness distribution of the galactic center region are given for resolutions of 1.″8, 0.″8, and 0.″25. A comparison of the infrared and radio observations shows that the dominant infrared source and the radio source Sagittarius A have the same coordinates and similar sizes. An analysis of the observed infrared radiation predicts about 25 mag of visual absorption between the Sun and the galactic center if the source of infrared radiation is stellar. A comparison is also made between the infrared radiation from the galactic center and that from the nucleus of M31 which shows agreement in both the apparent structure and infrared luminosity of the two nuclei. (auth)

13155 THE LUMINOSITY FUNCTION FOR THE GLOBULAR CLUSTER M13. Simoda, Mahiro (Goddard Inst. for Space Studies, New York); Kimura, Hiroshi. Astrophys. J., 151: 133-43(Jan. 1968).

The luminosity function for M13 was obtained down to the visual magnitude 19, by means of star counts on the plates taken with the 74-inch reflector of the Okayama Astrophysical Observatory. Particular attention was paid to the counting method. A significant difference was found between the luminosity function and the M3 luminosity function determined by Sandage. The result for M13 gives a generally steeper gradient when compared with Sandage's result for M3. By use of the luminosity function and the Population-II stellar models given by Icko Iben, Jr., the lifetime and effective helium core mass were obtained for each evolutionary stage up to the giant tip. Agreement between the present results and the theoretical ones is good, both for the low ($Y_e = 0.10$) and high ($Y_e = 0.35$) helium cases contrary to the results obtained by Sandage for M3. Lifetimes for the horizontal-branch stars were found to be 9×10^7 years for $X_e = 0.9$ and 5×10^7 years for $X_e = 0.65$. Some evidences which seem to favor the high helium content are discussed. (auth)

13156 NEUTRAL HYDROGEN OBSERVATIONS OF THE BINARY GALAXY SYSTEM NGC 4631/4656. Roberts, Morton S. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 151: 117-31(Jan. 1968).

A link or "bridge" of neutral atomic hydrogen connecting the galaxies NGC 4631 and NGC 4656 is described. The galaxies are separated by 0.°5 at a distance of 4 Mpc, the minimum separation of their centers is 38 kpc. The systemic radial velocities of the two galaxies agree to within ~30 km/s. The hydrogen content for the entire system is 6.1×10^9 $M_\odot$, of which 0.7×10^9 $M_\odot$ is associated with the bridge. Ten of the observed drift curves for NGC 4631 can be satisfactorily reproduced by a set of drift curves generated from a model galaxy that is convolved with the observing antenna beam. Such a procedure yields a rotation curve as well as the distribution and random motions of the hydrogen. The best fitting model has a random motion term of 30 km/s. These data yield an estimate of the average optical depth for this nearly edge-on system. Several of the drift curves, corresponding to velocities of the east end of the galaxy, are only poorly reproduced by the model. They are better matched if an expansion term is included in the analysis. However, any adopted model is not necessarily a unique representation of the data. The adopted rotation curve indicates a total mass for NGC 4631 of 6.8×10^{10} $M_\odot$; the neutral hydrogen is 6% of the total mass. No satisfactory model for NGC 4656 could be found, although a systemic radial velocity of about 600 km/s is indicated. A rough estimate of the total mass of this system is $1.5 \times 10^{10}/\sin^2 i$ $M_\odot$. The fractional hydrogen content is $0.09 \sin^2 i$. (auth)

13157 INTEGRATED MAGNITUDES AND COLOR INDICES OF THE FORNAX DWARF GALAXY. de Vaucouleurs, G.; Ables, H. D. (Univ. of Texas, Austin). Astrophys. J., 151: 105-16(Jan. 1968).

Integrated magnitudes and colors of the Fornax dwarf spheroidal galaxy derived from photoelectric scans with the 36-inch reflector are $B_T = 9.04$ ($M_T = -13.0$ if $m - M = 22.0$), $\langle B - V \rangle = +0.63$, $\langle U - B \rangle = +0.08$. The luminosity distribution shows a nearly uniform central core of $\langle r \rangle \simeq 6'$ and maximum brightness $\mu_0(B) = 24.6$ mag sec^{-2} in an envelope of gradient $G(a) = d(\log I)/da = -0.077$ min^{-1} = -1.15 kpc^{-1}. The effective equivalent radius is $\langle r_e^* \rangle = 9.'4$ where $\mu_e(B) = 25.2$ mag sec^{-2} and the system may be detected out to an average diameter in excess of 1°. The photometry is compared with star counts by Hodge and with new counts on a 40-inch reflector plate. (auth)

13158 THE ROTATION AND MASS OF NGC 1808. Burbidge, E. Margaret; Burbidge, G. R. (Univ. of California, San Diego). Astrophys. J., 151: 99-103(Jan. 1968).

The velocity field in the dusty Sb galaxy NGC 1808 was investigated. The rotation was measured, and from it, it is found that the mass is close to 2.7×10^{10} $M_\odot$. The mass-to-light ratio is about 2. Large-scale departures from circular motion amounting to ~100 km/sec are found at between 25″ to 50″ from the center on the northwest side. A brief discussion of the excitation conditions in the H II regions is given. The Na I D blend in absorption is so strong that it may be due to interstellar gas in the galaxy. (auth)

13159 STUDIES OF EXTRAGALACTIC NEBULAE. V. MOTIONS IN THE SEYFERT GALAXY NGC 1068. Walker, Merle F. (Univ. of California, Mt. Hamilton). Astrophys. J., 151: 71-97(Jan. 1968).

Spectroscopic observations in seven position angles were obtained with the prime-focus spectrograph and with the Lallemand electronic camera attached to the focus of the coudé spectrograph of the 120-inch reflector. These spectra reveal the presence in the nucleus of three or four discrete clouds of material with internal turbulent velocities and velocities with respect to the center of up to 600 km/sec. The diameters of these clouds are of the order of 200 to 350 pc, their masses of the order of 10^6 to 10^7 $M_\odot$, and their characteristic expansion ages of the order of 10^5 to 10^6 years. Similar clouds are directly observable or inferred in the Seyfert galaxies NGC 4151 and NGC 7749, and in the elliptical galaxy NGC 4486. The presence of a synchrotron component in the optical-region radiation of the nucleus is suggested by the photoelectric

detection of a polarization of 8.8% in ultraviolet light; the polarization in yellow light is ≤0.5%. Measurable optical-region polarization was also detected in the nuclei of the Seyfert galaxies NGC 1275, NGC 5448, and NGC 7469, being particularly strong in NGC 1275, which is the radio source 3C 84. Analysis of the velocity curves outside the nucleus indicates that out to a radial distance of r ~ 25″ the motion is a combination of rotation and expansion, while beyond r = 30″, only rotation occurs. Thus, the entire central region is disturbed, perhaps as a result of an earlier generation of the type of violent event now observed in the nucleus. Comparison is made with other galaxies showing ejection of material, and bearing of the discrete nature of the ejection and its probable repetition at intervals of the order of 10^6 years (and possibly much less) on proposed explanations of the source of the large energy release in the nuclei of Seyfert galaxies and radio sources is discussed. (auth)

13160 STOCHASTIC THEORY FOR THE WAVELENGTH DEPENDENCE OF LINEAR POLARIZATION OF RADIO SOURCES. Goldstein, Samuel J. Jr. (Univ. of Virginia, Charlottesville). Astrophys. J., 151: 65-9(Jan. 1968).

A model for radio sources is presented in which the source is a sum of perfectly polarized elements. Some of the elements have identical angles, and the remainder have polarization angles which are independent random variables. Each of the elements is viewed through a Faraday rotation which is also an independent random variable. These assumptions lead to a formula for the wavelength dependence of the fractional polarization that fits the observed polarization of many but not all sources. (auth)

13161 POLARIZED BRIGHTNESS DISTRIBUTION OVER CASSIOPEIA A, THE CRAB NEBULA, AND CYGNUS A AT 1.55-CM WAVELENGTH. Mayer, C. H.; Hollinger, J. P. (Naval Research Lab., Washington, D. C.). Astrophys. J., 151: 53-63(Jan. 1968).

Observations with 1′.7 resolution were made of Cassiopeia A, the Crab Nebula, and Cygnus A using the 140-foot reflector of the National Radio Astronomy Observatory and a polarimeter at 1.55-cm wavelength which measured directly the intensity with linear polarization oriented north-south and the Stokes parameters Q and U. These data were combined to determine the distribution of the total intensity of radiation, the intensity of linearly polarized radiation, and the degree and position angle of linear polarization for scans across the sources spaced at 0′.8 intervals of declination. Cassiopeia A at 1.55-cm wavelength is a nearly circular source with enhanced regions of emission aroung the rim and remarkably symmetrical linear polarization of about 4.5% around the rim and zero at the center of the source. The electric field is oriented circumferentially defining a radial magnetic field associated with the polarized radiation. The total intensity contours of the Crab Nebula source are roughly elliptical and similar in shape and position to the outer envelope of the nebula, but the intensity of polarized radiation is concentrated in a smaller region centered about 0′.5 south and 0′.25 east of the center of the nebula with a maximum degree of polarization of about 16% at position angle 154°. The distributions of total intensity and polarized intensity of Cygnus A are consistent with two point sources separated by 1′.9 along position angle 109°. The total intensity of the east component is 12% greater than that of the west component. The intensities of linearly polarized radiation from the two components are equal, but the polarization is nearly opposite. (auth)

13162 OBSERVATIONS OF THE RADIO SOURCES 3C 84, 3C 273, 3C 274, AND 3C 279 AT SHORT CENTIMETER WAVELENGTHS. Allen, R. J.; Barrett, A. H.; Crowther, P. P. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 151: 43-52(Jan. 1968).

The radio flux and linear polarization characteristics of the sources 3C 84, 3C 273, 3C 274 (Virgo A), and 3C 279 were determined at two or more of the wavelengths 3.85, 3.64, 1.97, and 1.90 cm (7.8, 8.25, 15.25, and 15.75 GHz, respectively). The observations covered the time period May, 1965, to March, 1967, and reveal secular flux variations for 3C 84, 3C 273, and 3C 279. The increase in flux from 3C 273 during the period 1964 to mid-1966 ceased abruptly in May, 1966, at 2 cm and in September, 1966, at 3.64 cm. The 3C 273 observations are shown to be in quantitative agreement with a recently proposed theoretical model of quasi-stellar radio-flux time variations. The angular size of 3C 274 (Virgo A) was found to be 1′.0 + 0′.1 at 3.64-cm wavelength and 0′.53 + 0′.05 at a wavelength of 1.94-cm wavelength. An unsuccessful search for the 90α recombination line of atomic hydrogen in the emission spectrum of 3C 273 was conducted with a detectability limit of 0.03°K. (auth)

13163 SKY SURVEY OF HIGH-ENERGY COSMIC X RAYS AND SPECTRA OF THE SOURCES IN THE CRAB NEBULA AND CYGNUS. Clark, G. W.; Lewin, W. H. G.; Smith, W. B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Astrophys. J., 151: 21-32(Jan. 1968). (MIT-2098-385).

The northern sky from right ascension 19^h to 7^h and declination −10° to +75° was surveyed on July 19, 1966, for x-ray sources above 20 keV in a single flight with a balloon-borne detector having a sensitive area of 368 cm^2, a 12° FWHM field of view, and a direction determination accuracy of ±2°. Two intensity peaks were observed, each with a signal-to-noise ratio greater than 25 to 1. One was identified with Tau X-1 (the Crab Nebula), and the other with Cyg X-1 and/or Cyg X-3. The spectral data of the two peaks were similar in the observed range between 20 and 100 keV and could be described in terms of incident spectra in the form of $dN/dE \sim E^{-(3+a)}$ with $a = 0.6 \pm 0.2$, as well as in the form of $(1/E) \exp(-E/kT)$ with $kT = 60 \pm 20$ keV. The intensity ratio of the two peaks was Cyg/Tau X-1 = 0.84 ± 0.10 in the energy range from 20 to 70 keV. No other intensity peak greater than one-eighth that of Tau X-1 was found in the region of sky surveyed and more than 10° away from the centers of both the Taurus and Cygnus peaks. This region includes the blue, starlike X-ray source Cyg X-2, the supernova remnants Cas A and Cas B (Tycho's SN_I), the Andromeda galaxy M31 and the radio sources 3C 403, 3C 446, CTA 102, 3C 93, 3C 9, 3C 47, 3C 147. Since Cyg X-2 has an intensity at 3 keV comparable to that of the combined intensities of Cyg X-1 and Cyg X-3 in rocket observations at 3 keV, but was not discernible at 30 keV, it has a significantly steeper spectrum than Cyg X-1 and Tau X-1 from 3 to 30 keV as does Sco X-1, which has a similar optical appearance. (auth)

13164 MODELS OF NINE RADIO SOURCES FROM LUNAR OCCULTATION OBSERVATIONS. Taylor, J. H. (Harvard Coll. Observatory, Cambridge, Mass.); De Jong, M. L. Astrophys. J., 151: 33-42(Jan. 1968).

Twenty-six lunar occultations of nine radio sources have been observed with the 140-foot telescope at the National Radio Astronomy Observatory. The observations were made simultaneously at frequencies of 234, 256, and 405 Mc. Positions of the sources are determined with accuracies ranging from 1′.5 to 8″, and optical identifications are suggested for two of the sources that previously had not been correctly identified. Six of the sources, namely 3C 44, 3C 133, 4C 26.19, 3C 154, MSH 21-29, and MSH 21-123, were observed at two different position angles, and simple two-dimensional models are derived for them. More detailed two-dimensional brightness distributions are derived for the other three sources, 3C 76.1, 3C 192, and 4C 10.31, that were observed at four or more position angles. (auth)

13165 OBSERVATIONS OF GALACTIC X-RAY SOURCES. Fisher, Philip C.; Jordan, Willard C.; Meyerott, Arthur J.; Acton, Loren W.; Roethig, Douglas T. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Contracts NAS 5-1174; NASw-909. Astrophys. J., 151: 1-19(Jan. 1968).

The final results of a 1964–1965 survey for galactic x-ray sources in the interval $330° < l^{II} < 160°$ are summarized. Attention was restricted to relatively low galactic latitudes. Fifteen discrete sources were located to an accuracy of about ±1°, and another eight sources were tentatively identified and located. Seven of the twenty-three sources had a 4- to 8-keV x-ray luminosity which varied significantly over the 1-year span of the measurements. The intensities of at least eight of the brighter sources were not found to have varied appreciably with time. Seven of the brighter and relatively time-invariant sources at the lowest galactic latitude were found to lie within the interval $358° < l^{II} < 17°$. The observations were used to prepare a rudimentary color-magnitude diagram; color being defined as the response of a specified detector to 5- to 10-keV photons divided by that detector's response to 2.8- to 5.0-keV photons. Evaluation of the color-magnitude diagram's information and the two galactic position coordinates of the x-ray sources indicates that seven relatively time invariant sources having $358° < l^{II} < 17°$ may all have had an effective temperature of $\sim 5 \times 10^7$°K. This is the reported effective temperature of Sco X-1 and Cyg X-2, which have been found by other workers to have a nova-like character. It appears that a single physical phenomenon is occurring in these particular sources, and that this phenomenon has a nova-like character at optical wavelengths and can on occasion be found in Population I objects. (auth)

13166 ^{87}Rb–^{87}Sr ISOCHRON AND ^{40}K–^{40}Ar AGES OF THE NORTON COUNTY ACHONDRITE. Bogard, D. D.; Burnett, D. S.; Eberhardt, P.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett., 3: 179-89(Dec. 1967).

Analysis of seven different portions of Norton County yielded Rb/Sr ratios ranging from 0.15 to 2.3 and permitted the determination of an isochron with high precision. The Rb and Sr concentrations were found to be as low as ~0.16 ppM. All of the data lie to

within their experimental errors on a line in the Sr evolution diagram of slope 0.0654 ± 0.0014, and intercept 0.700 ± 0.002. This determines an age of 4.7 ± 0.1 × 10^9 yr for λ = 1.39 × 10^{-11} yr^{-1}. $^{40}K-^{40}Ar$ ages on samples containing 42, 53, and 107 ppM K gave ages of 4.2 to 4.5 × 10^9 yr, which are compatible with the Rb–Sr age. The K appears to be concentrated in alkali feldspar grains of about 5 to 50 microns. The $^{87}Rb-^{87}Sr$ age and primary $^{87}Sr/^{86}Sr$ value is of sufficient precision to permit the age resolution of meteoritic objects formed 0.3 × 10^9 yr apart. No evidence of element redistribution was found for Norton County as indicated by the consistency of our Rb–Sr and K–Ar results. (auth)

13167 THE ORIGIN OF THE 'EXCESS' ^{39}A IN STONE METEORITES. Begemann, F.; Vilcsek, E.; Waenke, H. (Max-Planck-Institut fuer Chemie, Mainz). Earth Planet. Sci. Lett., 3: 207-12 (Dec. 1967).

A stepwise dissolution technique was used to determine argon-39 decay rates in three different mineral fractions of the enstatite chondrite Abee. As the ratios FeNi : Ca : K were highly different, the production rates on these elements could be determined; they were found to be (21.0 ± 1.0), (60 ± 30), and (7450 ± 500) dpm/kg on FeNi, Ca, and K, respectively. Hence, in meteorites with a chondritic Ca/K ratio the argon-39 in excess of that to be expected from reactions on iron and nickel alone is almost entirely due to the (n,p) reaction on potassium-39. The average neutron flux (E ≳ 1.5 MeV) in Abee during the last 400 years was $\phi \approx 60$ neutrons per cm^2 sec. Evidence is presented that in different stone meteorites this flux differs by at least a factor of ten, that in Abee being on the high side. (auth)

13168 BLUE END OF THE HORIZONTAL BRANCH IN GLOBULAR CLUSTERS. Hartwick, F. D. A.; Harm, R.; Schwarzschild, M. (Princeton Univ., N. J.). Astrophys. J., 151: 389-92(Jan. 1968).

Faulkner (1966), Faulkner and Iben (1966), and Iben (1967) developed theoretical evidence for the hypothesis that the horizontal branch in globular clusters represents that phase of the evolution of a star in which it consumes the helium in its core. It is the purpose of this note to describe a certain specific consequence of this hypothesis and to point out that this specific consequence would appear to be accessible to an observational test by modern photoelectric methods. (auth)

13169 EXCITATION OF CORONAL EMISSION LINES AS A MEASURE OF ELECTRON DENSITY. Zirin, H. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 151: 383-7(Jan. 1968).

Coronal lines in the visible spectrum may be classified by whether they are excited from the ground state by photospheric radiation and collisions or by collisions only. Since the latter disappear at low density, the peculiar behavior of several lines is explained and a density criterion obtained. (auth)

13170 THE GREAT POST-LIMB EVENT OF MARCH 2, 1966. Miller, Richard A. (Manila Observatory). Astrophys. J., 151: 379-81(Jan. 1968).

At 0312 U.T. on March 2, 1966, a growing calcium plage, numbered 8174 by the McMath–Hulbert Observatory and first observed on Feb. 21 at N. 22° E. 31°, was completely beyond the west limb of the Sun by several hours. At this time the region was apparently the site of a major flare, for which the ionospheric effects were well established, at least 20 min before any flare phenomena at Hα were visible. Ionospheric and rf phenomena recorded at the Observatory are discussed and spectroheliograms taken in the K_3 line are shown. (W.D.M.)

13171 SOLAR LONGITUDE DISTRIBUTIONS OF PROTON FLARES, METER BURSTS, AND SUNSPOTS. Haurwitz, Marion W. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Astrophys. J., 151: 351-64(Jan. 1968).

The need for an analysis of proton flares over a long time scale is discussed and a sample of inferred proton events, covering a century, is described. The analysis of this sample shows that these high-energy events are distributed nonrandomly in solar longitude in a rigidly rotating system with period $27^d.213$, considerably shorter than the Carrington period ($27^d.275$). The distribution of meter bursts associated with the proton flares is also studied in this longitude system and found to be strongly nonrandom. Two different samples of sunspots, however, studied over as many as eight solar cycles, do not show any significant nonrandom organization in either the $27^d.213$ or the $27^d.275$ system. (auth)

13172 STUDY OF X-RAY IMAGES OF THE SUN AT SOLAR MINIMUM. Reidy, W. P.; Vaiana, G. S.; Zehnpennig, T.; Giacconi, R. (American Science and Engineering, Cambridge, Mass.). Astrophys. J., 151: 333-49(Jan. 1968).

A set of solar x-ray photographs obtained using grazing-incidence optics at solar minimum is analyzed. The spatial distribution of the x-ray radiation above 20 Å is shown to be consistent with models of the general coronal emission by Elwert. A model for the x-ray emission from a plage is constructed by use of the experimental data on temperature, volume, and density of the emitting regions. The results obtained in x rays are compared to the 9.1 cm spectroheliogram, the Hα spectroheliogram, and the magnetogram of the Sun obtained simultaneously by ground observation. It is shown that the ionized plasma which produces the observed x-ray emission also accounts for the observed radio emission at 9.1 cm. Thus, it is concluded that the correlation between enhanced radio emission and x rays from this plage region is due to a common physical process which is responsible for both. The lifetime and the mode of confinement of such an ionized plasma are discussed. It is shown that energy injection must occur during the life of the plage to account for the observed persistence. It is also shown that the observed magnetic field would be capable of containing the plasma if it extends to the coronal heights in which the plasma is maintained. (auth)

13173 DEVIATIONS FROM LTE IN STELLAR PHOTOSPHERES. Kalkofen, W. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Univ., Cambridge, Mass.). Astrophys. J., 151: 317-32(Jan. 1968).

The equations of statistical equilibrium are considered for the case of detained balancing in the strong lines, an assumption that is valid in the photosphere. The equations are specialized to low particle density and applied to stars in the spectral class range from B to K. The direction in which the populations in the bound state of H^- and in atomic hydrogen deviate from their LTE values is predicted essentially from the temperature increase into the star and the concomitant change, with depth, in the spectral distribution of the continuous flux. It is found that the H^- state is overpopulated; the lower hydrogen levels are underpopulated, and the higher levels overpopulated relative to the LTE values. The effects of the departures on the emergent continuous spectrum are such that, for given effective temperature, giants tend to be classified earlier than dwarfs, if the continuous flux of LTE models is used; also, in A and F stars the surface gravity that is determined from the color tends to be overestimated. The influence of line blanketing and convection on the departures from LTE is briefly discussed. (auth)

13174 SOLUTION OF TRANSFER EQUATIONS SUBJECT TO THE CONSTRAINT OF RADIATIVE EQUILIBRIUM. Auer, I. H.; Mihalas, Dimitri (Univ. of Colorado, Boulder). Astrophys. J., 151: 311-16(Jan. 1968).

A method is proposed for solving transfer equations subject to the constraint of radiative equilibrium. The approach uses the differential-equation form of the transfer equation and thus allows easy generalization. A description is given of the equations and boundary conditions, and results for gray and non-gray cases are discussed. Rapid convergence is obtained at all depths. It appears that this method should be effective in non-LTE cases, though in practice it may be limited by the size of matrix that can be inverted economically. (auth)

13175 STATISTICAL EQUILIBRIUM MODEL ATMOSPHERES FOR EARLY-TYPE STARS. III. HYDROGEN AND HELIUM CONTINUA. Mihalas, Dimitri; Stone, Michael E. (Princeton Univ., N. J.). Astrophys. J., 151: 293-310(Jan. 1968).

Results are presented for model atmospheres allowing for departures from LTE in hydrogen, helium, and ionized helium on the temperature range 10000°K ≤ T_{eff} ≤ 36,000°K. The essential simplifying assumption made is that all radiative bound–bound transitions are in detailed balance. While this assumption is valid in certain physical circumstances, it is not everywhere correct, and the results derived here should be regarded as only exploratory. As was the case in earlier results, the departures found are quite small and have only small effects upon the emergent energy distribution, so that LTE appears to be a fairly adequate approximation in the calculation of the continuous energy distribution. No information concerning line formation can be inferred from the present results. (auth)

13176 THE ABUNDANCE OF HELIUM IN A- AND B-TYPE STARS. Morton, Donald C. (Princeton Univ., N. J.). Astrophys. J., 151: 285-91(Jan. 1968).

A new scale of effective temperatures determined from line-blanketed model atmospheres was used to obtain luminosities of twelve components of the best determined eclipsing binaries. These stars along with the primary of the visual binary Sirius are compared with the theoretical mass–luminosity relation for main-sequence stars in order to estimate helium abundances. For these Population-I stars He/H is about 0.08 ± 0.02 by number,

though the ratio could be larger if there is nonuniform rotation within the stars. This ratio is consistent with that obtained for the Sun by the same method, and is not much smaller than the value He/H ~ 0.11 found in diffuse nebulae. (auth)

13177 FAR-ULTRAVIOLET SPECTROSCOPY AND PHOTOMETRY OF SOME EARLY-TYPE STARS. Carruthers, George R. (Naval Research Lab., Washington, D. C.). Astrophys. J., 151: 269-84(Jan. 1968).

An Aerobee-150 rocket launched from White Sands Missile Range on March 16, 1967, carried an all-reflecting image-converter spectrograph and two Geiger-tube photometers for studies of the far-ultraviolet radiation of early-type stars. The image converter was of the Lallemand (electronographic) type, and was sensitive in the wavelength range 950 to 1400 Å. The two photometers were sensitive in the wavelength ranges 1050 to 1180 and 1230 to 1350 Å, respectively. The instrumentation was pointed at eight targets during the flight by the rocket attitude control system. Spectral and photometric data were obtained at all positions, and a total of at least sixteen stars (some as faint as 4.65 mag) were detected by the spectrograph in 3- and 10-sec exposures. Both the spectra and the photometry indicate that stellar fluxes fall off rapidly in the wavelength range below Lyman-α. The deficiency appears to be greater than can be accounted for by present information on line blanketing and interstellar absorption, and may be due to selective absorption by specific constituents of the interstellar medium. The spectral resolution was generally 2 to 3 Å and revealed appreciable differences in the width of the Lyman-α absorption line in the various stars observed. The spectrum of γ Ori is compared with the theoretical model of a B1.5 V star by Mihalas and Morton in the 1150 to 1350 Å range, and other spectra are compared with previous ones obtained by Morton. Wavelength shifts of the Si III λ1207 Å and C III λ1175 Å lines indicate that gas is escaping at high velocity from γ Vel and ζ Pup, as well as from several of the stars in Orion. (auth)

13178 STUDIES OF THE PECULIAR A STARS. V. CONTINUOUS ENERGY DISTRIBUTIONS. Jugaku, Jun; Sargent, Wallace L. W. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Contract AF 49(638)-1323. Astrophys. J., 151: 259-67(Jan. 1968).

Spectral scans were made of the continuous energy distributions in the wavelength region $\lambda\lambda$3300 to 5700 of seventeen Ap stars and five A- and B-type normal stars. The scans have a resolution of 10 Å and are supplemented by Hγ profiles measured on coudé spectra. The peculiar stars observed include seven Mn stars, three λ4200-Si and one Si–Eu–Cr stars, five Si–Eu–Cr stars, and one star, 21 Aql, which has been described as a Si star. It is shown empirically that the scans and Hγ profiles of the peculiar stars match those of normal A and B stars and then compare them with the predictions of model atmospheres computed by Mihalas. It is found that the hotter normal and peculiar stars do not match the models in the sense that the observed gradients in the Paschen continuum are too shallow; however, the observed Balmer discontinuities give effective temperatures in good agreement with those obtained by other methods. Hence effective temperatures and surface gravities for the stars in the program were obtained by using only the Balmer discontinuity and the Hγ profile of each star. The results confirm earlier papers in this series in showing that most of the Ap stars have the atmospheric characteristics of B stars and that the Mn stars stand out in that they occupy a much smaller range in the (θ-log g) plane than the other Ap stars. It is emphasized that the principal result is that the atmospheres of the Ap stars do not differ in a detectable way from those of normal A or B stars. On the other hand, the values of θ and log g given may need substantial revision when better model stellar atmospheres become available. (auth)

13179 MOLECULAR BAND INTENSITIES IN G AND K STARS. Schadee, Aert (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Contract AF 49(638)-1323. Astrophys. J., 151: 239-57(Jan. 1968).

Intensities of CO, CH, C2, and CN bands are studied for G and K stars with various surface gravities and metal content, assuming different C, N, and O compositions. Atmospheric models are based on a scaled, solar T(τ) relation. A simple method predicts the molecular intensities accurately, and it is therefore not necessary to work out the equilibria of all possible C, N, and O compounds in detail. The dependences of the computed band intensities on the metal content, T_{eff}, and g are discussed and found to be in agreement with the observations. The possibilities of determining CNO abundances from observed band intensities are also discussed. The molecular equilibria are dominated by the association of CO, which is complete for stars later than KO. Two independent spectral features are required to determine the C and O abundances, like the G band and an [O I] line in oxygen-rich giants. In oxygen-rich dwarfs, there is only one easily observable feature, the G band, which yields a relation between O and C. In carbon-rich stars the C_2 and CH intensities are not independent since each is a function of the abundance difference between carbon and oxygen. For oxygen-rich dwarfs and carbon-rich stars the second datum required to derive O and C can only be obtained from infrared CO observations. The nitrogen abundance may be determined from CN bands for carbon-rich stars, if the C–O abundance difference is known, and for oxygen-rich stars, if both the carbon and the oxygen abundances are known. The division of late-type stars into oxygen-rich and carbon-rich is extremely sharp; differences of more than 1% from the mathematical equality O = C places a star in either class. All bands of C and N compounds are formed near $\tau \approx 0.1$ in carbon-rich stars and, except for CO, near $\tau \approx 1$ or 2 in oxygen-rich stars. Especially in the latter stars, the optical depth of formation $\langle\tau\rangle$ is a function of the CNO composition, and since the carbon depletion is a critical function of both τ and the CNO composition, an a priori assumption of $\langle\tau\rangle$ in determining abundances may lead to erroneous results. (auth)

13180 CRYSTALLIZATION OF WHITE DWARFS. Van Horn, H. M. (Univ. of Rochester, N. Y.). Astrophys. J., 151: 227-38(Jan. 1968).

At the temperatures and densities characteristic of the interiors of the white dwarfs, the ions begin to freeze into a regular lattice structure. On the assumption that the transition to the solid state is a first-order phase change, it is shown that the release of the latent heat of crystallization is sufficient to slow the rate of cooling of the white dwarfs, with the consequent formation of "crystallizing sequences" in the H–R diagram. Comparison of the theoretically predicted sequences with the two groups of white dwarfs observed by Eggen and Greenstein suggests that stars in the fainter group are the direct descendants of the helium-burning red giants, while those in the brighter group are the end product of a more advanced stage of stellar evolution. (auth)

13181 THE EFFECTS OF AXIAL ROTATION ON THE EQUIVALENT WIDTHS OF SPECTRAL LINES. I. WEAK RESONANCE LINES. Collins II, George W. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware). Astrophys. J., 151: 217-26(Jan. 1968).

Analysis of the effects of axial rotation upon the formation of weak resonance lines in early-type stars is considered. It is demonstrated that the primary effects on the line strengths are due to the geometry of the distortion and the center-to-limb variation of the line strengths. Variation of the parameters defining the stellar interior will affect the line strength only to a very limited degree. It is shown that the effects of rotation upon a pure scattering line are qualitatively different from a pure absorption line. It is suggested that the moderately small changes in line strength predicted for scattering lines and the relatively large color changes may imply a scatter in the relationship between photometric color and spectral type. (auth)

13182 UNIFORMLY ROTATING MAIN-SEQUENCE STARS. Faulkner, J. (Peterhouse, Cambridge, Eng. California Inst. of Tech., Pasadena); Roxburgh, I. W.; Strittmatter, P. A. Astrophys. J., 151: 203-16(Jan. 1968).

Models of homogeneous, uniformly rotating main sequence stars were constructed by an extension of the method described by Roxburgh, Griffith, and Sweet and results for three stellar masses are presented. Detailed opacity and nuclear energy generation data were included and the prescription due to Faulkner, Griffiths, and Hoyle was adopted to determine the surface boundary conditions. By subsequently fitting appropriate "gray" atmospheres at each latitude the changes in visual magnitude V and color index B–V were evaluated for a range of rotational velocities and aspect angles. At maximum rotational speed there are found to be differences of up to 1.3 mag in V and 0.25 mag in B–V for stars of the same mass seen at different orientation. The maximum spread in the main sequence ranges between 0.4 and 1.2 mag depending on color. (auth)

13183 OBSERVATIONAL EVIDENCE FOR OVERTONE PULSATIONS IN CLASSICAL CEPHEIDS. Fernie, J. D. (Univ. of Toronto). Astrophys. J., 151: 197-202(Jan. 1968).

On the basis of a period–radius relation obtained from radius determinations for fifteen Cepheids by Wesselink's method, it is suggested that η Aql, W Sgr, β Dor, and X Cyg are pulsating in the first overtone, and that U Car may be pulsating in the third overtone. No simple, decisive observational criterion has been found for distinguishing overtone pulsators from fundamental-mode pulsators, and since the former make up one-third of the fifteen stars examined, the determination of individual absolute magnitudes by the period–luminosity relation will frequently be

liable to considerable error. Application of the period–luminosity relation for fundamental pulsators to first-overtone pulsators will underestimate their luminosities by about 0.4 mag, while in the case of third-overtone pulsators the luminosity will be underestimated by about 1.0 mag. It is pointed out that where only a few Cepheids have been measured in an external galaxy, this effect could lead to a significant error in determining the slope of the P–L relation in that galaxy. Unlike their counterparts among the RR Lyrae stars, overtone pulsators among classical Cepheids do not appear to be restricted to any particular period range. (auth)

13184 SPECTROPHOTOMETRIC-STUDIES OF GASEOUS NEBULAE. VIII. THE IRREGULAR PLANETARY NEBULA NGC 2440. Aller, L. H. (Univ. of California, Los Angeles); Czyzak, S. J.; Kaler, J. B. Astrophys. J., 151: 187-95(Jan. 1968).

By photographic and photoelectric techniques emission-line intensities in the spectrum of the irregular, high-excitation planetary nebula NGC 2440 was measured between λ3109 and λ5016 Å to a minimum intensity at peak instrumental sensitivity of 2×10^{-4} I (Hβ). This object shows a wide range of excitation, from [Mg I] to O IV and [Ne V]. Electron temperatures and densities appear to be normal. The electron density in the outer parts of the nebula away from the central condensations is about 10^3 cm^{-3}. (auth)

13185 ISOTOPIC COMPOSITION OF TRAPPED KRYPTON AND XENON IN CHONDRITES. Marti, Kurt (Univ. of California, San Diego, La Jolla). Earth Planet. Sci. Lett., 3: 243-8 (Dec. 1967).

The isotopic compositions of Kr and Xe in some carbonaceous and disequilibrium chondrites are reported. The following isotopic abundances of Kr and Xe in the trapped primordial heavy rare gas component are obtained: $^{78}Kr : {}^{80}Kr : {}^{82}Kr : {}^{83}Kr : {}^{84}Kr : {}^{86}Kr$ = 0.01920 : 0.1263 : 0.6490 : 0.6507 : 3.230 : 1.000 and $^{124}Xe : {}^{126}Xe : {}^{128}Xe : {}^{130}Xe : {}^{131}Xe : {}^{132}Xe : {}^{134}Xe : {}^{136}Xe$ = 0.00452 : 0.00406 : 0.0809 : 0.1613 : 0.815 : 1.000 : 0.381 : 0.320. These trapped gases are compared with those in the terrestrial atmosphere. The nature of the anomalies is discussed. (auth)

13186 KRYPTON AND XENON ISOTOPIC COMPOSITION IN THREE CARBONACEOUS CHONDRITES. Eugster, O.; Eberhardt, P.; Geiss, J. (Univ. of Bern). Earth Planet. Sci. Lett., 3: 249-57 (Dec. 1967).

The concentration and isotopic composition of Kr and Xe were measured in the three carbonaceous chondrites Cold Bokkeveld, Lancé, and Orgueil. Spallation corrections and, in the case of Cold Bokkeveld, neutron effects are shown to be negligible. In general, results agree with the trapped Kr isotopic composition observed in gas-rich and unequilibrated chondrites and with results of other investigators. The significance and the possible origin of the observed anomalies are briefly discussed. (A.G.W.)

13187 SOLAR OBLATENESS AND FLUID SPIN-DOWN. McDonald, B. E.; Dicke, R. H. (Princeton Univ., N. J.). Science, 158: 1562-4 (Dec. 22, 1967).

An experiment performed on a differentially rotating, density-stratified fluid shows that "spin-down" need not occur under the condition of stratification. Inasmuch as density stratification occurs in the interior of the Sun, spin-down probably does not exist in the solar interior, and the observed solar oblateness may indicate that the Sun contains a rapidly spinning core. (auth)

13188 RADIOACTIVE NUCLEI IN SOLAR COSMIC RAYS. Kuzhevskii, B. M. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.), 6: 279-81 (Oct. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 832-4(Oct. 15, 1967).

The production of all possible radioactive nuclei in solar radiation is considered. (M.O.W.)

13189 OBSERVATION OF THE CYGNUS REGION WITH A BALLOON-BORNE X-RAY DETECTOR. Chodil, G.; Mark, Hans; Rodrigues, R.; Swift, C. D. (Univ. of California, Livermore). Contract W-7405-eng-48. Astrophys. J., 151: L1-3 (Jan. 1968). (UCRL-70731).

A NaI(Tl) scintillation detector was carried by a balloon to an atmospheric depth of 3.2 g/cm^2 on April 29, 1967, from Chico, California. The x-ray spectrum between 23 and 80 keV was obtained for Cyg X-1. It can be fitted by a synchrotron spectrum with an index of $a = -0.5$ and an integrated intensity of 2.4×10^{-4} ergs cm^{-2} sec^{-1}. This agrees with previous measurements and indicates that Cyg X-1 has probably not experienced a measurable change in intensity during the past 2 years. (auth)

13190 ROCKET ULTRAVIOLET SPECTROPHOTOMETRY IN THE ORION REGION. Boggess III, Albert; Kondo, Yoji (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 151: L5-7(Jan. 1968).

Low-resolution uv spectra of several bright stars in the region of Orion were photographed from an Aerobee rocket launched at White Sands on Nov. 29, 1965. The intent was to obtain objectively dispersed spectrograms suitable for relative spectrophotometry of early-type stars. Three cameras were flown. They were small Schmidt systems operating at T/1.0 with 28-mm focal lengths and 30° fields of view. Results are given for those stars for which the data are most reliable. (W.D.M.)

13191 OBSERVATION OF GAMMA RADIATION FROM THE CRAB NEBULA. Haymes, R. C.; Ellis, D. V.; Fishman, G. J.; Kurfess, J. D.; Tucker, W. H. (Rice Univ., Houston, Tex.). Astrophys. J., 151: L9-14(Jan. 1968).

This Letter reports the detection of gamma radiation from the Crab Nebula with a balloon-borne instrument. Hard x rays from this object have been previously observed by several groups; the present experiment has in addition detected radiation up to 560 keV. The gamma-ray detector was a 4-in.-diameter by 2-in.-thick NaI(Tl) crystal viewed by an RCA 8054 phototube. (W.D.M.)

13192 PHOTOELECTRIC OBSERVATIONS OF SCO X-1. Stepien, Kazimierz (Univ. of California, Santa Cruz). Astrophys. J., 151: L15-17(Jan. 1968).

The source Sco X-1 was observed photoelectrically on four consecutive nights between May 17 and May 21, 1967, with the 24-inch reflector of the Lick Observatory and standard UBV equipment. The primary purpose was to obtain simultaneous observations in optical and x-ray regions of the spectrum. The observations were not of optimum quality because conditions for photoelectric observations were very unfavorable. (W.D.M)

13193 DIFFUSE X-RAY BACKGROUND. Silk, Joseph (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 151: L19-22(Jan. 1968).

The isotropic x-ray background may be interpreted by means of the superposed contributions from normal galaxies, provided that one takes into account evolutionary effects of the type suggested by the radio source counts. (auth)

13194 OPTICAL POSITIONS OF 25 QUASI-STELLAR OBJECTS AND RADIO GALAXIES. Lu, Phillip K.; Fredrick, Laurence W. (Univ. of Virginia, Charlottesville). Astrophys. J., 151: L23-6(Jan. 1968).

Twenty-five additional optical positions of quasi-stellar objects and radio galaxies obtained from McCormick plates are presented. 3C 15 is suspected of variability. (auth)

13195 QUASI-STELLAR RADIOSOURCES: 88-GHz FLUX MEASUREMENTS. Schorn, Ronald A. (Jet Propulsion Lab., Pasadena, Calif.); Epstein, Eugene E.; Oliver, John P.; Soter, Steven L.; Wilson, William J. Contracts F04695-67-C-0158; NAS 7-100. Astrophys. J., 151: L27-31(Jan. 1968).

The flat or turned-up nature of the high-frequency spectra of a number of QSS and related objects was confirmed by measurements at 88 GHz (3.4 mm). "Light" curves are presented for 3C 273 and 3C 279. The 3.4-mm flux variations of 3C 273 are substantially larger than those observed at longer wavelengths. 3C 84 and the QSS 3C 345, 3C 446, 3C 454.3, and 4C 39.25 were also detected, but CTA 102 was not. The Seyfert galaxies NGC 1068, NGC 4151, and 4C 05.20 were observed; NGC 1068 and 4C 05.20 were detected, but NGC 4151 was not. (auth)

13196 THE GALACTIC RADIO SOURCE DR 21 AT 3.3 MM. Riegel, Kurt W. (Univ. of California, Los Angeles); Epstein, Eugene E. Contract F04695-67-C-0158. Astrophys. J., 151: L33-4(Jan. 1968).

The flux of DR 21 at 3.3 mm is $(21 \pm 4) \times 10^{-26}$ W m^{-2} Hz^{-1}; this value is consistent with a model of DR 21 consisting of a single high-density thermal component. (auth)

13197 A SUGGESTED DEPOPULATION MECHANISM FOR THE HELIUM 2^3S STATE IN PLANETARY NEBULAE. Robbins, R. R. (Univ. of Texas, Austin). Astrophys. J., 151: L35-9 (Jan. 1968).

Excitation of doubly excited auto-ionizing states of helium by line emission from the central star may be a significant depopulating mechanism for the 2^3S state in some nebulae. Discrepancies between observation and theory are particularly lessened for compact objects, but for many nebulae this mechanism is probably competitive with two-photon emission. (auth)

13198 LIMITS ON THE $^{12}C/^{13}C$ RATIO IN METAL-DEFICIENT STARS. Cohen, J. G. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Grasdalen, G. L. Astrophys. J., 151: L41-3(Jan. 1968).

Lower limits for the ratio $^{12}C/^{13}C$ were determined for eight metal-deficient stars. These limits are inconsistent with the predictions of nearly all of the universal models considered by Wagoner, Fowler, and Hoyle (1967) unless at least one generation of massive, rapidly evolving stars existed before the formation of any of the program stars. (auth)

13199 A VERY RED OR HIGHLY-REDDENED STAR NEAR NGC 6231. Sanduleak, N. (Case Western Reserve Univ., Cleveland. Cerro Tololo Inter-American Observatory, La Serena, Chile). Astrophys. J., 151: L45(Jan. 1968).

A very red star was found in the region of NGC 6231. The possibility exists that the star is a highly reddened member of the cluster. (auth)

13200 MODEL ATMOSPHERE EFFECTS IN UBV PHOTOMETRY OF LATE DWARFS AND SUBDWARFS, AND THE HELIUM CONTENT OF THE OLDEST FIELD SUBDWARFS. Dennis, Tom. R. (Princeton Univ., N. J.). Astrophys. J., 151: L47-50(Jan. 1968).

A series of non-gray, LTE, unblanketed model atmospheres in mixed radiative and convective equilibrium has recently been computed. In each case, the temperature distribution has been so adjusted that the total flux is constant with depth to 1% or better. This Letter points out the existence of several effects associated with the metal content parameter but quite distinct from Fraunhofer line blanketing, which affect the emergent continuum flux in the UBV bands. (W.D.M.)

13201 NARRABRI SCALE OF ABSOLUTE STELLAR FLUXES. Popper, Daniel M. (Univ. of California, Los Angeles). Astrophys. J., 151: L51-3(Jan. 1968).

Measurement of the angular diameters of fifteen hot stars by Brown, Davis, Allen, and Rome (1967) furnishes fundamental new data of great importance in observational astrophysics: absolute radiative fluxes. It is the purpose of this Letter to point out that the observed values of the normalized correlations at zero separation of the mirrors are compatible with the conclusion that all the stars for which the fluxes are being published are single with the exception of the hottest star, β Cru, and that the observed flux for this star should be decreased by about 8.5%. (W.D.M.)

13202 AN IRON SPARK LINE LIST IN THE 10 TO 18 A RANGE AND ITS COMPARISON WITH FLARE SPECTRA. Feldman, U.; Cohen, L. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 151: L55-8(Jan. 1968).

By use of a low-inductance vacuum spark, spectra of highly ionized Fe in the region 10 to 18 Å were recorded. The low-inductance (0.16-μH) discharge circuit consisted of a 13-μF capacitor charged to 12 to 19 kV and triggered by the discharge of a Tesla coil placed near the ground electrode. The spectra were recorded on Kodak SWR glass plates using a modified Jarrell–Ash 3-m, 88°-angle-of-incidence spectrometer. The grating was a 1200 line/mm Bausch and Lomb gold replica, blazed at 2° 35′. An aluminum filter partially removed some zero-order fogging. By varying the voltage between 12 and 19 kV, lines from ions Fe XVI to Fe XXIV were recorded. (W.D.M.)

13203 METALS ON THE LUNAR SURFACE. Sun, K. H. (Westinghouse Research Labs., Pittsburgh). Nature (London), 217: 243-4(Jan. 20, 1968).

The author has suggested that metallic iron, aluminium, and magnesium may exist on the lunar surface as a result of chemical reduction by atomic hydrogen accumulated from long bombardment by solar wind protons, and the large number of H atoms available and the continuous turnover of the lunar surface layer throughout the ages suggest a metal-containing layer a few feet in thickness. The present communication further discusses these suggestions. (UK)

13204 VENUS CLOSELY OBSERVED. Stubbs, Peter. New Sci., 37: 66-7(Jan. 11, 1968).

Preliminary results from Mariner 5 which passed close to Venus on October 19, 1967, taken with those of the Soviet Venus 4 softlander, reveal that the planet's dense, hothouse atmosphere traps light rays, and its ionosphere repels the solar wind. (auth) (UK)

13205 NOBLE GASES IN THE FAYETTEVILLE METEORITE. Manuel, O. K. (Univ. of Missouri, Rolla). Geochim. Cosmochim Acta, 31: 2413-31(Dec. 1967).

Noble gases were extracted from the dark portions of the meteorite by heating the sample to successively higher temperatures up to 1600°C. Analyses of the neon evolved at each temperature indicate that this gas is a mixture of at least three components, and it is shown that the observed isotopic composition could be produced from a mixture of primordial neon, cosmogenic neon, and highly mass-fractionated primordial neon. The isotopic compositions of helium, neon, and argon indicate a primordial component for which $^3He:{}^4He \leq 0.00031$, $^{38}Ar:{}^{36}Ar \leq 0.177$, $^{20}Ne:{}^{22}Ne \geq 12.6$, and $^{21}Ne:{}^{22}Ne \geq 0.033$. The xenon spectra show an excess of the heavy xenon isotopes, with a mass-yield curve intermediate between that observed in the Pasamonte meteorite and that in the earth's atmosphere. It is shown that this atmosphere-like xenon component is not due to contamination, but is definitely a component of meteroritic xenon. (auth) (UK)

13206 SOLAR ABUNDANCE OF LIGHT ELEMENTS. O'Mara, Bernard James. Los Angeles, Univ. of California, 1967. 226p.

Thesis.

The solar abundances of carbon, nitrogen, oxygen, sodium, magnesium, aluminum, silicon, phosphorous, sulphur, potassium, and calcium were determined. In the analysis an abundance was derived from each line and wherever possible the line profile rather than the equivalent width was used. Careful attention was paid to the details of Stark broadening and van der Waals broadening for the lines employed. In many cases it was necessary to increase the theoretical van der Waals broadening in order to match the observed line profile. For sodium an abundance analysis was performed using previously computed non-LTE departure coefficients. It was found that these calculations gave abundances that were less consistent than those obtained by a LTE analysis. It was also found that for certain lines of calcium non-LTE effects appear to be present. For the other elements departures from LTE, if present, are within the uncertainty of the f values. The abundances obtained differ somewhat from those contained in previous determinations. These differences are due principally to the model atmosphere used in this analysis and in the case of magnesium to the influence of Stark broadening. (Disser. Abstr.)

13207 ANGULAR MOMENTUM EFFECTS OF SOLAR AND STELLAR WINDS. Modisette, Jerry Lee. Houston, Tex., Rice Univ., 1967. 80p.

Thesis.

The solar wind stretches the solar magnetic fields out to large distances, and the rotation of the Sun twists the field into a spiral. This spiral field exerts a torque on the Sun, and couples the rotation of the Sun to the interplanetary medium. The angular momentum loss of the Sun is determined by the solution of the equation of conservation of angular momentum for the solar wind to be that calculated by assuming rigid-body rotation of the corona out to the point at which the radial velocity is equal to the radial Alfvén velocity. However, it is also shown that the angular momentum lost from the Sun is divided between the solar-wind particles and the interplanetary magnetic field, with the distribution depending upon the details of the radial velocity variation with radial distance. Using radial velocity profiles based on an isothermal corona, and on a model assuming rapid acceleration of the solar wind near the Sun, the torque and the radial profile of angular velocity are calculated for a range of field magnitudes, solar-wind velocities, and solar-wind densities. The torque can produce an exponential decay of the solar rotation with a time constant close to the main-sequence lifetime of the Sun. (Disser. Abstr.)

13208 K-LINE PHOTOMETRY OF A STARS. Henry, Richard Conn. Princeton, N. J., Princeton Univ., 1967. 128p.

Thesis.

A narrow-band photoelectric grating slot spectrometer, compensated for seeing and transparency variations, was constructed. Observations of the strength of the calcium K line were obtained for 146 A stars using this spectrometer, and the telescope facilities of Kitt Peak National Observatory. It is found that if Am stars are excluded, which is possible using four-color and Hβ photometry, the K line measure permits a reddening-independent estimate of the b−y color with an rms error of 0^m01. For normal stars, the deviation of a star from the mean relation found between the K line strength and b−y color is found to be well correlated with Stromgren's metallicity indicator, $\Delta[m_1]$. Am stars are found to have generally very weak K lines, as expected, but a surprising number have normal strengths. Fifteen of the spectrum variables listed by Bertaud (1959, J. des Observateurs, 42: 45) were observed over thirteen days; ten were found to be variable in the K line at the time of observation. In addition, five new suspected variables were identified. Comparison of the observations to LTE computations using Mihalas' models of A stars (1966, Ap. J. Suppl., 13: 1) shows excellent agreement of observations of normal stars and the computed results for solar abundance. The electron damping constant of Brechot and van Regemorter (1964, Ann. d'Ap., 27: 739) was used. The Am stars range from (apparent) normal calcium abundance to (apparent) one eighth solar abundance. Normal stars have a range in (apparent) abundance of less than plus or minus a factor two. (Disser. Abstr.)

13209 OPTICAL STUDY OF STELLAR FLARES. Kunkel, William Eckart. Austin, Tex., Univ. of Texas, 1967. 117p.

Thesis.

Eleven flare stars were observed through at least two outbursts each during a study of stellar flares conducted at the McDonald Observatory in 1965 and 1966. To determine good statistics of flare incidence about 30 flares were recorded on each of the most intensively observed stars, AD Leo, YZ CMi, and Wolf 359, monitored in sequentially sampled U, B, V. To identify the emission processes responsible for flare light, time-resolved low resolution (260 A mm^{-1}) spectra were obtained of flares on EV Lac, AD Leo, and YZ CMi. (Disser. Abstr.)

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Refer also to abstracts 12845, 13129, 13564, 13628, 13938, and 14069.

13210 (CALT-532-19) ENERGY TRANSFER IN MOLECULAR COLLISIONS. Riley, Merle Eugene (California Inst. of Tech., Pasadena). Dec. 18, 1967. Contract AT(04-3)-532. 285p. Dep. CFSTI.

Thesis.

Two general, numerically exact, quantum mechanical methods have been developed for the calculation of energy transfer in molecular collisions. The methods do not treat electronic transitions because of the exchange symmetry of the electrons. All interactions between the atoms in the system are written as potential energies. The first method is a matrix generalization of the invariant imbedding procedure, adapted for multichannel collision processes. The second method is based on a direct integration of the matrix Schroedinger equation, with a reorthogonalization transform applied during the integration. Both methods have been applied to a collinear collision model for two diatoms, interacting via a repulsive exponential potential. Two major studies were performed. The first was to determine the energy dependence of the transition probabilities for an H_2 on H_2 model system. Transitions are possible between translational energy and vibrational energy, and from vibrational modes of one H_2 to the other H_2. The second study was to determine the variation of vibrational energy transfer probability with differences in natural frequency of two diatoms similar to N_2. Comparisons were made to previous approximate analytical solutions of this same problem. For translational-to-vibrational energy transfer, the previous approximations were not adequate. For vibrational-to-vibrational energy transfer of one vibrational quantum, the approximations were quite good. (auth)

13211 (UUIP-548) THE K-LEVEL ENERGY OF BERYLLIUM IN METAL, OXIDE, AND FLUORIDE. Hamrin, K.; Johansson, G.; Fahlman, A.; Nordling, C.; Siegbahn, K. (Uppsala Univ. (Sweden). Inst. of Physics). May 1967. 9p. Dep.

The K-level of beryllium in metal, oxide, and fluoride was studied by electron spectroscopy for chemical analysis. The data were compared with those obtained by X-ray spectroscopy and with a study of the disintegration constant in electron capture of ^7Be in the same compounds. (auth) (Sweden)

13212 (AD-661902) INTRODUCTION TO THE THEORY OF ATOMIC SPECTRA. Sobel'man, I. I. Translation of Vvedenie v Teoriyu Atomnykh Spektrov, Gosudarstvennoye Izdatel'stvo, Moscow, 1963. 761p. (FTD-MT-64-542; TM-7500314). CFSTI.

The book is devoted to a systematic presentation of the physical bases and the theory of atomic spectroscopy. The presentation is based on the modern theory of angular moments. There is also a systematic examination of the problems of excitation and radiation of atoms. These problems are of interest from the point of view of the use of spectroscopic methods in investigating various physical phenomena. (auth)

13213 (ANL-Trans-563) TABLES FOR THE CALCULATION OF MATRIX ELEMENTS OF OPERATORS OF ATOMIC QUANTITIES. Karaziya, R. I.; Vizbaraite, Ya. I.; Rudzikas, Z. B.; Yutsis, A. P. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Tablitsy Dlya Rascheta Matrichnykh Elementov Operatorov Atomnykh Velichin, Moscow, 1967. 131p. Dep. CFSTI. JCL $10.50 fs, $4.13 mf.

Tables are given of fractional parentage coefficients and of submatrix elements U^k and V^{kl} (k = 1, 2, . . ., 2l and l is the orbital quantum number). They cover all p, d, and f electrons up to 4 electrons. The tables are given for partially filled shells. (M.O.W.)

13214 CRITICAL SCATTERING OF ELECTRONS BY POLAR MOLECULES. Levy-Leblond, J. M.; Provost, J. P. (Faculte des Sciences, Nice). Phys. Lett., 26B: 104-6(Dec. 25, 1967).

A theoretical analysis is given of slow electrons scattering by polar molecules with nearly critical dipole moments. (auth)

13215 HYPERFINE STRUCTURE OF MUONIUM. Halpern, Otto (American Express Co., London). Acta Phys. Austr., 25: 367-8(Dec. 1967).

Continuing an earlier investigation on the influence of the uncertainty principle on the measurement of magnetic moments of unstable particles, this article is concerned with the hyperfine structure of muonium. It is found that the experimental value for the hyperfine structure is ascribed a greater accuracy than the uncertainty principle allows. (auth)

13216 CHARGE-TRANSFER CROSS SECTIONS FOR THE REACTION $N_2^+ + O_2 \rightarrow O_2^+ + N_2$ AT VERY LOW ENERGIES. Golden, D. E.; Sinnott, G.; Varney, R. N. (Lockheed Research Lab., Palo Alto, Calif.). Phys. Rev. Lett., 20: 239-41(Feb. 5, 1968).

The charge-transfer cross section for $N_2^+ + O_2 \rightarrow O_2^+ + N_2$ has been measured by a drift-tube technique in the formerly inaccessible energy region from 0.05 to 1 eV in the center-of-mass system. In this energy region the charge-transfer cross section σ may roughly be represented by $\sigma = 2.2\ \text{Å}^2/(\text{cm energy in eV})^{1/2}$. This expression is consistent with a model dominated by the induced dipole interaction, and it connects smoothly thermal-energy measurements to ion-beam measurements at several eV. (auth)

13217 ELECTRIC-FIELD AND MULTIPLE-FOIL EXCITATION EXPERIMENTS ON BEAM-FOIL-EXCITED HYDROGEN ATOMS. Bickel, William S. (Univ. of Arizona, Tucson). J. Opt. Soc. Amer., 58: 213-21(Feb. 1968).

Four experiments involving individual and combined effects of electric fields and multiple exciter foils on beam-foil-excited hydrogen atoms are described. The use of multiple exciter foils shows that excitation equilibrium does not occur in the thin carbon foils used here. The change of the rate of decay of Ly-α flux emitted by beam-foil-excited hydrogen atoms in an electric field has been used to determine the relative populations of the 2s and 2p levels at the foil. The 2s level is overpopulated with respect to the 2p level when one foil is used and two exciter foils enhance the overpopulations. Photoelectric measurements of Ly-α flux and photographic measurements of the decay of Balmer-δ flux emitted by atoms in an electric field show that quasiperiodic intensity variations exist on the decay curve. The variations are attributed to the effect of the electric field but discrepancies arise between the experimental frequencies and those calculated from Stark-effect theory. (auth)

13218 HOW GOOD IS THE HARTREE-FOCK APPROXIMATION. Moshinsky, M. (Univ. de Mexico, Mexico). Amer. J. Phys., 36: 52-3(Jan. 1968).

The problem of two particles in a common harmonic oscillator potential interacting through harmonic oscillator forces is discussed from the standpoint of the Hartree–Fock approximation and compared with the exact solution. (auth)

13219 POSITRONIUM FORMATION IN THE REACTIONS OF POSITRON WITH HYDROGENLIKE ATOMS. Roy, T.; Das, J. (Jadavpur Univ., Calcutta). Nuovo Cim. (10), 53B: 1-6(Jan. 11, 1968).

The cross section for positronium formation in positron–hydrogen collisions was calculated in the lowest-order approximation from the viewpoint of field theory for bound states in quantum electrodynamics. The result is compared with that of Massey and Mohr and seems to be better as regards the position of the peak value. (auth)

13220 CROSS SECTIONS FOR IONIZATION OF IONS BY ELECTRON IMPACT. Beigman, I. L.; Vainshtein, L. A. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 712-15(Jan.-Feb. 1968).

Translated from Astron. Zh., 44: 889-92(July-Aug. 1967).

Effective cross sections are computed for ionization from several levels of C^{3+} and C^{4+} ions in the Born–Coulomb and Born approximations. Values of $\langle v\sigma \rangle$ are obtained for a Maxwellian electron velocity distribution. In the temperature range of interest in practice the Coulomb-field correction is less than 30%. (auth)

13221 OPTICAL LIFETIME MEASUREMENTS USING A POSITIVE ION VAN DE GRAAFF ACCELERATOR. Nichols, L. L.; Wilson, W. E. (Battelle Memorial Inst., Richland, Wash.). Appl. Opt., 7: 167-70(Jan. 1968).

A system for direct observation of excited-state optical mean lives using the delayed coincidence counting techniques is described. The system uses a pulsed proton beam for excitation, a high speed time-to-amplitude converter and an on-line digital computer for data reduction. Mean lives longer than 1 nsec can be measured. Preliminary measurements on the 3^1P, 4^3S, and 4^1D levels of helium and several vibrational bands of N_2 are presented to illustrate the capabilities of the system. (auth)

13222 PRODUCTION OF LYMAN-α RADIATION IN COLLISIONS OF ELECTRONS ON MOLECULAR HYDROGEN (0.05 TO 3 keV). De Heer, F. J.; Moustafa Moussa, H. R.; Inokuti, M. (FOM-Inst. for Atomic and Molecular Physics, Amsterdam). Chem. Phys. Lett., 1: 484-6(Dec. 1967).

Lyman-α radiation has been measured resulting from collisions of electrons on H_2 at 0.05 to 3 keV. The asymptotic behavior of the cross section shows a strong contribution from collision-induced optical dipole transitions. (auth)

13223 CORRELATION ENERGY OF THE TWO-ELECTRON ATOM IN A SPHERICAL POTENTIAL BOX. Gimarc, B. M. (Univ. of South Carolina, Columbia). J. Chem. Phys., 47: 5110-15(Dec. 15, 1967).

Results of calculations approximating the electronic Coulomb correlation energy of the two-electron atom in a spherical potential box are reported and discussed. Although the total electronic energy of such an atom varies rather widely with changes in the radius of the box, the correlation energy seems to be relatively insensitive to such changes except for box radii on the order of or smaller than the atomic radius. (auth)

13224 ELECTRON IMPACT EXCITATION OF THE $c\ ^3\pi_u$ STATES OF H_2 AND D_2 BY A TRAPPED-ELECTRON METHOD. Dowell, J. T.; Sharp, T. E. (Lockheed Palo Alto Research Lab., Calif.). J. Chem. Phys., 47: 5068-73(Dec. 15, 1967).

Electron impact excitation of H_2 and D_2 within 0.05 eV of threshold is studied with a trapped-electron method. An ac RPD technique is used to achieve energy resolution better than 0.1 eV. A series of trapped-electron peaks is resolved in the 11.7- to 13.5-eV range. These are identified as vibrational levels of the $c\ ^3\pi_u$ state. In this energy range, excitation of other states (both singlet and triplet) near threshold is found to be weak by comparison. Several peaks observed in the 13.8- to 15.4-eV range could not be assigned to excitation of vibrational levels of a single electronic state. (auth)

13225 ENERGY DEPENDENCE OF ION–MOLECULE REACTIONS. Dunbar, Robert C. (Stanford Univ., Calif.). J. Chem. Phys., 47: 5445-6(Dec. 15, 1967).

While the Langevin r^{-4} potential is the largest term for nonpolar molecules at low energy, there are additional terms which can be important in ion–molecule reactions. Induction and dispersion attractive potentials are calculated for the reaction of CH_4^+ with CH_4, and the orbiting collision cross section is graphed as a function of E_0. The correction from the r^{-6} terms is typically 10% in the region around 0.1 eV, where the Stevenson–Gionmousis theory is most applicable. The interpretation of ion cyclotron double-resonance experiments is considered. (D.L.C.)

13226 CONTRIBUTIONS TO THE HYPERFINE STRUCTURE OF SPECTRAL LINES. Draganescu, V. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 19: 859-924(1967). (In Rumanian).

The hyperfine structure and the isotopic shift of spectral lines are due to the influence of the nucleus on atomic spectra. In order to determine the nuclear properties involved, new methods of high-resolution interference spectroscopy were developed. The experimental equipment used by the authors included: special light sources, making it possible to restrict the Doppler, Stark, and pressure effects; a Fabry–Perot interferometer with a reference standard; and the recording system, consisting of a photographic plate or a photomultiplier. The recording precision of the system was between 0.2 and 0.4%. Using the theoretical principles developed by N. Ionescu–Pallas, the optically determined magnetic moment values of ^{23}Na and ^{199}Hg reported in the literature were redetermined with greater precision. The new values agree with those determined by means of Rabi's magnetic resonance method. The radius of the nucleus of mercury determined from the isotopic shift was found to be $r_0 = (1.17 \pm 0.08) \times 10^{-13}\ A^{1/3}$. It was concluded that optical methods are of great potential importance for nuclear physics. (Thesis, 110 references) (TTT)

13227 IONIZATION AND ELECTRON TRANSFER IN COLLISIONS OF TWO H ATOMS: 1.25 TO 117 keV. McClure, G. W. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 166: 22-9 (Feb. 5, 1968).

Cross sections for electron loss and electron capture by H atoms in encounters with H target atoms are measured in the energy range 1.25 to 117 keV. The electron loss process is measured for H on H_2 as a check on the method. Three methods of controlling the excited-state distribution of the H atom beam are investigated in the energy range 25 to 100 keV. One method achieves a nearly pure 1s-state beam. Results are compared with theoretical Born-approximation calculations by Bates and Griffing; the theoretical cross section for the ionization process is about 0.5 times the experimental value at 20 keV and equal to the experimental value at ~80 to 100 keV. The experimental values of the electron-capture cross section are a factor of 2.5 to 3 below Mapleton's Born calculations. The quantum-number dependence of the ionization cross section is deduced from a comparison of cross-section measurements obtained with the different beam-preparation methods. If the ionization cross section is assumed to vary as n^α, where n is the quantum number of the excited projectile atom and α is a constant, it is found that α lies between 0 and 1, with most probable values <0.36 for H on H_2 and <0.77 for H on H. (auth)

13228 DOUBLE IONIZATION OF HELIUM BY FAST PROTONS. Oldham, William J. B. Jr. (Manned Spacecraft Center, Houston, Tex.). Phys. Rev., 166: 34-6(Feb. 5, 1968).

Born approximation calculations are presented for the cross section of the double ionization of helium by 1 to 3-MeV protons. The wave functions of helium are approximated by products of hydrogenlike, one-electron orbitals. Physically reasonable values of the screening parameters involved are used in the calculations. The results are compared with the two existing sets of experimental values for the production of He^{2+} by protons. The calculated values are found to agree more closely with the second experiment than with the first. However, the calculated cross section decreases with increasing proton energy as $E^{-0.83}$ which is considerably slower than the experimental values of $E^{-1.27}$ and $E^{-1.16}$. (auth)

13229 SELF-CONSISTENT CALCULATION OF VAN DER WAALS FORCE CONSTANT. Sengupta, S.; Mukherji, A. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., 166: 36-9(Feb. 5, 1968).

A self-consistent variation-perturbation procedure for calculating the van der Waals force coefficients between two atoms or molecules is presented. The theory is suitable for application to atoms containing a large number of electrons. Results for H–H and He–He systems are given here, and they show reasonably good agreement with the accepted values. (auth)

13230 SINGLE- AND DOUBLE-ELECTRON CAPTURE BY 7.7- TO 166-keV $^3H^{+}$ IONS IN N_2. Stearns, J. Warren, Berkner, Klaus H.; Honey, Vincent J.; Pyle, Robert V. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 166: 40-3(Feb. 5, 1968). (UCRL-17493; UCRL-17493(Rev.)).

The cross sections σ_{21} and σ_{20} for single- and double-electron capture of $^3He^{2+}$ ions with energies between 7.7 and 166 keV have been measured in thin targets of N_2. Our results join quite smoothly to higher-energy measurements by others. (auth)

13231 SINGLE- AND DOUBLE-ELECTRON CAPTURE BY 7.2- TO 181-keV $^3He^{+}$ IONS IN He. Berkner, Klaus H.; Pyle, Robert V.; Stearns, J. Warren; Warren, John C. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 166: 44-6(Feb. 5, 1968). (UCRL-17650).

The cross sections σ_{21} and σ_{20} for single- and double-electron capture of $^3He^{2+}$ ions with energies between 7.2 and 181 keV have been measured in thin targets of He. Our results join quite smoothly to other measurements at higher and lower energies. There is good agreement with the calculations by Ferguson and Moiseiwitsch and those by Fulton and Mittleman for double-electron capture. (auth)

13232 OPTICAL POTENTIAL AND INELASTIC SCATTERING OF ELECTRONS BY ATOMS. Kelly, Hugh P. (Univ. of Virginia, Charlottesville). Phys. Rev., 166: 47-53(Feb. 5, 1968). (ORO-2915-76).

The optical potential is expressed in terms of the perturbation expansion for the self-energy of the single-particle Green's function. Choices for the intermediate single-particle states for atoms are discussed, and it is shown that certain sets of these states are appropriate to describe resonances and inelastic scattering by means of the optical potential. The inelastic-scattering cross section is expressed in terms of the partial-wave expansion. Third- and higher-order terms are examined, and it is shown that for the Coulomb potential the expansion contains divergent terms. Multiple atomic excitations, including electron ionization, are also shown to be described by the diagrammatic methods of this paper. (auth)

13233 APPROXIMATE VARIATIONAL SOLUTION OF THE THOMAS–FERMI EQUATION FOR ATOMS. Csavinszky, P. (TRW Systems, Redondo Beach, Calif.). Phys. Rev., 166: 53-6(Feb. 5, 1968).

An approximate solution of the Thomas–Fermi (TF) differential equation is obtained by making use of an equivalent variational principle. The trial solution, depending on several parameters, is chosen in such a way that it satisfies the boundary conditions imposed on the TF equation together with the subsidiary condition that the electron density be normalized. The numerical values of

the parameters are determined by extremalizing the variational expression with respect to the parameters. Using the approximate solution, one finds that at large distances from the nucleus, the radial electron density decreases exponentially, as required by quantum mechanics—in contrast to the original TF theory, where the above quantity decreases as the inverse fourth power of the distance from the nucleus. The approximate TF function is then used for calculating the energy necessary to remove all electrons of an atom and for calculating the interaction energies between atoms in the Firsov approximation. In the former case the improvement upon the original TF theory is found to be substantial, and in the latter the interaction energies closely approximate Abrahamson's interaction energies based on the Thomas–Fermi–Dirac model. (auth)

13234 LIGHT-ION CHARGE EXCHANGE IN ATMOSPHERIC GASES. Koopman, David W. (Univ. of Maryland, College Park). Phys. Rev., 166: 57-62(Feb. 5, 1968).

Measurements of the total charge-exchange cross sections of H^+, H_2^+, and He^+ in N_2, O_2, CO_2, and H_2O have been made, using a collision chamber to collect the slow collision products. An energy range from 40 to 1500 eV was examined. Except for protons incident on N_2 and O_2, the processes examined have cross sections which continue to rise at energies below 200 eV; some collision products were found to have energies of several eV. Excited states must be invoked to explain the observed results in terms of the adiabatic criteria. Comparisons with earlier work are given. (auth)

13235 MEASUREMENTS OF CLOSE ENCOUNTERS IN H-ON-H, H-ON-H_2, AND H^--ON-H COLLISIONS. Keever, William C.; Lockwood, Grant J.; Helbig, Herbert F.; Everhart, Edgar (Univ. of Connecticut, Storrs). Phys. Rev., 166: 68-70(Feb. 5, 1968).

Close encounters are studied in the collision of hydrogen atoms with hydrogen atoms at incident energies of 2 to 60 keV. Those incident particles which are scattered through an angle of 1.5 or 3° are examined to find the fraction P_{+1} which have lost an electron in the encounter, the fraction P_0 which have remained neutral, and the fraction P_{-1} which have captured an electron. The P_{-1} component, which is a measure of the reaction $H + H \rightarrow H^- + H^+$, is everywhere low, at these scattering angles, never exceeding 4%, but it does show an interesting oscillatory structure. This quantity has a maximum evident at 7.5 keV and suggested maxima at 50 and 3.5 keV. Similar measurements are made for the H-on-H_2 collision, and these show a peak in the H^- production at 12 keV. For the H^--on-H collision, measurements of P_{+1}, P_0, and P_{-1} are made where the fast particle is scattered through 1.2°. No oscillatory structure is seen in this case for incident energies between 2 and 50 keV. (auth)

13236 DYNAMICAL GROUPS AND RELATIVITY. Bacry, Henri (Univ., Marseille). pp 79-124 of Lectures in Theoretical Physics. Vol. IX A. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

It is shown that a relativistic generalization of a dynamical group does not lead to another dynamical group. The little group and connected concepts (Pryce–Foldy–Wouthuysen transformations, Newton–Wigner position operator, etc.) are discussed. These ideas are presented in a way that is based on geometrical concepts. Also dynamical groups in classical mechanics and quantum mechanics are considered. The case of the spinless hydrogen atom is discussed separately just as its relativistic generalization. A formal analogy with the Klein–Gordan spectrum proves that the group concept is not sufficient in physics. Finally, a new geometrical structure which could be useful in elementary particle symmetries is introduced. (J.F.P.)

13237 QUANTUM STATISTICS OF MULTI-MODE RADIATION FROM AN ATOMIC ENSEMBLE. Letokhov, V. S. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 53: 2210-22(Dec. 1967). (In Russian).

The statistics of quantum fluctuations of multi-mode radiation from an ensemble of two-level atoms is studied theoretically. A master equation is derived which describes the evolution of the probability P_m^{N,n_l} for states with a prescribed number of atoms on the lower level m and n_l photons in the l-th mode, the total number of photons for the whole set of L modes being N. The equation is employed for finding the stationary distribution function yielding the number of photons in a single mode P^n and the total number of photons in all modes of equilibrium radiation from an atomic ensemble or of nonequilibrium radiation at negative temperature (below the self-excitation threshold). Nonlinear coupling between the radiation and atoms (saturation effect) must be taken into account in the case of nonequilibrium radiation. It is shown that in the case of nonequilibrium radiation the photon distribution function for a single mode is identical with the Bose–Einstein distribution for equilibrium radiation; however, the dispersion of fluctuations of the total number of photons N in all L modes is less than for equilibrium radiation with the same number of modes. (auth)

13238 MULTIELECTRON IONIZATION IN CLOSE COLLISIONS OF Ar AND Kr IONS AND ATOMS. Pivovar, L. I.; Krivonosov, G. A.; Tubaev, V. M. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz., 53: 1872-8 (Dec. 1967). (In Russian).

The angular and energy dependences of the charge fractions in Ar- and Kr-ion beams produced in collisions with Ar and Kr atoms are measured with a scintillation counter. The mean energy losses expended in ionization of the colliding particles and also the total effective cross sections for loss of many electrons by Ar^+ and Kr^+ ions in Ar and Kr are determined on basis of the results obtained. The measurements are carried out for 250- to 1700-keV Ar ions and 200- to 850-keV Kr ions at angles between 1 and 11°. (auth)

13239 PRODUCTION OF HIGHLY EXCITED HYDROGEN MOLECULES AND ATOMS BY FAST H_2^+ AND H_3^+ IONS PASSING THROUGH H_2, Ne, AND Mg AND Na VAPOR. Solov'ev, E. S.; Il'in, R. N.; Oparin, V. A.; Fedorenko, N. V. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 53: 1933-41(Dec. 1967). (In Russian).

The formation of highly excited H_2^* molecules and H^* atoms (principal quantum numbers $n > 8$) during the passage of fast 20 to 180-keV H_2^+ and H_3^+ ions through Ne, H_2 and Na and Mg vapor is investigated. The cross sections for formation of highly excited hydrogen molecules ($\sigma_{H_2^*}^n$) and hydrogen atoms ($\sigma_{H^*}^n$) are measured. The yield of highly excited molecules and atoms relative to the primary ion beam as a function of target thickness (H_2 of Mg vapor) is also measured. The yields of highly excited H^* atoms for various fast ions (H^+, H_2^+, H_3^+) and various targets are compared. The most effective target for highly excited hydrogen atom production is Mg vapor. In this case the greatest yield of highly excited atoms with energies below 40 keV is obtained as a result of fast proton charge exchange. At higher energies dissociation of fast H_3^+ ions is the more effective process. (auth)

13240 EXCITATION OF ELECTRONS IN SOLIDS BY RELATIVELY SLOW ATOMIC PARTICLES. Abroyan, I. A.; Eremeev, M. A.; Petrov, N. N. (Leningrad Polytechnic Inst.). Usp. Fiz. Nauk, 92: 105-57(May 1967). (In Russian).

In view of the fact that most data on the excitations of electrons in a solid by bombardment with ions or atoms with energies up to several times 10 keV are scattered throughout the literature, with the possible exception of electron and ion emission from polycrystalline metals, the authors have gathered and summarized the latest results, with emphasis on data pertaining to semiconductors and dielectrics as well as to single crystals. (ATD)

13241 ANGULAR COEFFICIENTS OF ATOMIC MATRIX ELEMENTS INVOLVING INTERELECTRONIC COORDINATES. Heintz, W. H.; Gibbs, R. L. (Clarkson Coll. of Tech., Potsdam, N. Y.). J. Math. Phys. (N. Y.), 8: 1817-28(Sept. 1967).

A method for determining the angular coefficients of atomic matrix elements is illustrated. The angular coefficients of matrix elements for r_{ij}^a, $r_{ij}^a r_{jk}^b$, $r_{ij}^a r_{jk}^b r_{kl}^c$, $r_{ij}^a r_{jk}^b r_{kl}^c$, and $r_{ij}^a r_{jk}^b r_{kl}^c r_{li}^d$ are evaluated using single-particle states of definite angular momentum. The use of tensor operators enables a separation into angular and radial parts. The atomic matrix elements are then expressed as sums over products of n–j symbols and radial integrals. These sums are restricted by the values of the single-particle state angular moments, and in all cases the effects of single-particle couplings disappear. The calculation does not require the use of a particular coordinate system, as is the case for multiple products of spherical harmonics. (auth)

13242 INELASTIC COLLISIONS BETWEEN EXCITED ALKALI ATOMS AND MOLECULES. III. SENSITIZED FLUORESCENCE AND QUENCHING IN MIXTURES OF POTASSIUM WITH N_2, H_2, HD, AND D_2. McGillis, D. A.; Krause, L. (Univ. of Windsor, Ont.). Can. J. Phys., 46: 25-32(Jan. 1968).

$4^2P_{\frac{1}{2}}-4^2P_{\frac{3}{2}}$ mixing in potassium, induced by collisions with N_2, H_2, D_2, and HD, was studied using techniques of sensitized fluorescence. The potassium vapor–gas systems, in which the potassium vapor pressure was kept very low to avoid radiation trapping, was irradiated with one component of the resonance doublet. The fluorescence, which contained both components of the doublet, was monitored at right angles to the direction of excitation. The following cross sections for mixing and quenching were obtained from measurements of relative intensities of the fluorescent components. For K–N_2 collisions: $Q_{12}(^2P_{\frac{1}{2}} \rightarrow {}^2P_{\frac{3}{2}}) = 100$ Å^2, $Q_{21}(^2P_{\frac{3}{2}} \leftarrow {}^2P_{\frac{1}{2}}) = 66$ Å^2, $Q_{10}(^2S_{\frac{1}{2}} \rightarrow {}^2P_{\frac{1}{2}}) = 35$ Å^2, Q_{20} ($^2S_{\frac{1}{2}} \leftarrow$

$^2P_{\frac{1}{2}}$) = 39 Å². For K–H_2 collisions: Q_{12} = 76 Å², Q_{21} = 53 Å², Q_{10} = 7 Å², Q_{20} = 4 Å². For K – D_2: Q_{12} = 72 Å¹², Q_{21} = 50 Å², Q_{10} = 2 Å², Q_{20} = 1 Å². For K–HD: Q_{12} = 74 Å² Q_{21} = 49 Å², Q_{10} = 11 Å², Q_{20} = 14 Å². An analysis of these results suggests the presence of resonances with the molecular rotational levels. (auth) (Canada)

13243 ENERGY LOSS FUNCTIONS FOR ELECTRONS AND PROTONS IN PLANETARY GASES. Green, A. E. S.; Peterson, L. R. (Univ. of Florida, Gainesville). J. Geophys. Res., 73: 233-41(Jan. 1, 1968).

Convenient analytic energy-loss functions are given for protons and electrons in the atomic and molecular gases as well as in some metals. Parameters are presented that lead to good fits to the available experimental data. Constants are also evaluated in an approximation that makes it very simple to deal with compounds and mixtures occurring in planetary atmospheres. These energy-loss functions, when taken in conjunction with analytic forms for excitation and ionization cross sections, may be used to calculate analytic energy transfer and secondary electron distribution functions and a range–energy relationship. Extension of the work to handle problems in which mixture ratios vary with altitude is also discussed. Here the analytic technique could be particularly useful to simplify theoretical studies of the various possible planetary atmospheres that must be considered at our present stage of knowledge. (auth)

13244 COHERENCE PROPERTIES OF THE BREMSSTRAHLUNG RADIATION. Bialynicka-Birula, Z. (Inst. of Physics, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 663-6(1967).

The bremsstrahlung radiation is considered in a weak external field. It is assumed that the electron is nonrelativistic so that the spin and pair production effects are negligible. All higher terms in v/c are neglected. Under these assumptions, the two-point correlation function and the degree of coherence for the electric field far from the scattering center are calculated in the lowest order of perturbation theory. (M.O.W.)

13245 ION CYCLOTRON RESONANCE SPECTROSCOPY. Baldeschwieler, John D. (Stanford Univ., Calif.). Science, 159: 263-73(Jan. 19, 1968).

The basic operating features of an ion-cyclotron resonance spectrometer are discussed. The results of several ion–molecule collision measurements are presented. (M.O.W.)

13246 X-RAY INTERFERENCE PASSING NEAR THE ABSORPTION K-EDGE OF Ge. Datsenko, L. I.; Skorokhod, M. Ya.; Vasil'kovskii, A. S. Ukr. Fiz. Zh., 12: 1925-7(Nov. 1967). (In Russian).

The effects of x rays in Lane radiograms for Ge crystals near the K absorption edge were studied. The magnitude μt for the long and short waves of the K-edge absorption Ge(λ_{crit} = 1.116 Å) was evaluated at crystal thickness t = 0.035 cm, μt = 6.1, and for λ_2 = 1.17 Å. Data indicated new x-ray waves near the K-absorption line. The dislocations introduced increased the K-absorption intensity. The experiments confirmed the effects of defects on the magnitude of the K-band absorption jump in the Lane radiogram. (R.V.J.)

13247 COLLISIONAL EXCITATION OF LOW-ENERGY PERMITTED TRANSITIONS BY CHARGED PARTICLES. Goss, W. Miller; Field, George B. (Univ. of California, Berkeley). Contract Nonr 222(66). Astrophys. J., 151: 177-85(Jan. 1968).

The method of Purcell and Rogers for calculating collisional excitation of low-energy permitted transitions by charged particles is generalized so that it can be used for any such transition with the use of tables presented here. The limitations of the method are discussed, and examples of current astrophysical interest, such as the excitation of interstellar OH, CH, and CN, are presented. (auth)

13248 RADIATION SPECTRA EXCITED BY β PARTICLES OF ^{204}Tl, ^{90}Sr, AND ^{90}Y IN SOME METALS. Kryukov, S. N.; Karamanova, Zh. S. Vestn. Mosk. Univ., Ser. II. Khim., No. 4, 114-16(July–Aug. 1967). (In Russian).

Spectra of bremsstrahlung and x radiation from a β source were studied with a detector placed at 45° to the target. The intensity and spectral distribution of characteristic x radiation and bremsstrahlung as a function of β energy and of the atomic number of the element were studied using ^{204}Te and ^{90}Sr–^{90}Y as emitters. The spectra obtained for Zr, Nb, Mo, Ag, Sn, Ce, Ta, W, Pt, and Pb were analyzed with a 100-channel analyzer and a scintillation spectrometer. Calibration of the analyzer was carried out using Zr, Sn, Ta, and Pt K lines excited by ^{14}C β particles. (R.V.J.)

13249 INFLUENCE OF PLURAL SCATTERING ON POLARIZATION AND ANGULAR DISTRIBUTION IN LOW-ENERGY ELECTRON SCATTERING. Eitel, Wilhelm; Jost, Klaus; Kessler, Joachim (Univ., Karlsruhe, Ger.). Z. Phys., 209: 348-54 (1968). (In German).

The influence of plural scattering on the angular distribution and spin polarization of slow electrons scattered by mercury atoms has been investigated at 180, 300 and 900 eV. Especially the high polarization peaks are very sensitive to plural scattering, while lower polarization values remain relatively unaffected. A simple explanation of the results is given. (auth)

13250 ISOTOPE SHIFT CONSTANTS OF Th, U, Pu, AND Am. Blaise, J. (Centre National de la Recherche Scientifique, Orsay, France); Steudel, A. Z. Phys., 209: 311-28(1968). (In German).

The isotope shifts of unperturbed electron configurations have been determined from isotope shift measurements in the spectra of Th, U, Pu, and Am. The screening of the 7s electron charge density at the nucleus by 6d, 7s, and 7p electrons is discussed. It turns out that the same screening factors as for the 6s electron in lighter elements can be used. The screening of the 7s electron charge density at the nucleus by one 5f electron amounts to about 25%: $[\Delta T(f^n s) - \Delta T(f^n)]/[\Delta T(f^{n-1} s) - \Delta T(f^{n-1})] = 0.7_5$. The charge density at the nucleus due to the filled s (and $p_{\frac{1}{2}}$) shells is considerably screened by an f electron. The isotope shift $\Delta T(f^{n-1}d^{m+2}) - \Delta T(f^n d^m)$ produced by this effect is of the same order of magnitude as the isotope shift $\Delta T(f^n d^m s) - \Delta T(f^n d^m)$ due to an s electron. The experimental isotope shift constants are found to be: β C_{exp} (^{230}Th–^{232}Th) = 880 ± 120; β C_{exp} (^{233}U–^{235}U) = 1000 ± 180; β C_{exp} (^{234}U–^{236}U) = 1070 ± 200; β C_{exp} (^{236}U–^{238}U) = 1080 ± 180; β C_{exp} (^{238}Pu–^{240}Pu) = 1200 ± 120; β C_{exp} (^{239}Pu–^{241}Pu) = 1060 ± 100; β C_{exp} (^{240}Pu–^{242}Pu) = 900 ± 90; β C_{exp} (^{241}Am–^{243}Am) = 890 ± 50 [10^{-3} cm^{-1}]. The ratios β C_{exp}/C_{th} are discussed. (auth)

13251 MULTIPOLE POLARIZABILITIES AND SHIELDING FACTORS OF THE HELIUM ISOELECTRONIC SEQUENCE. Cohen, M. (York Univ., Toronto). Can. J. Phys., 45: 3773-80 (Dec. 1967).

Analytical expressions are derived for the two leading terms in the Z expansions of the multipole polarizabilities and shielding factors of all members of the helium sequence. The derived numerical values of the octopole and hexadecapole polarizabilities are in excellent agreement with the estimates of Stewart (1961). (auth)

13252 MOMENTUM DISTRIBUTIONS OF TWO PHOTON ANNIHILATING POSITRON–ELECTRON PAIRS IN HEXANE AND DECANE. Chuang, S. Y.; Hogg, B. G. (Univ. of Manitoba, Winnipeg). Can. J. Phys., 45: 3895-900(Dec. 1967).

Momentum distributions are calculated for electrons in the C–C and C–H bonds in hydrocarbons, using analytic SCF functions for atomic carbon orbitals and Heitler–London-type functions for the two paired electrons in the C–C and C–H bonds. The positron wave function is assumed to be a constant. The computed momentum distributions are then compared with high-precision experimental distributions, obtained from positron-annihilation angular correlation experiments. (auth)

13253 MEASUREMENT OF THE TEMPERATURE DEPENDENCE OF ATOMIC AND MOLECULAR ION MOBILITIES IN HELIUM. Orient, O. J. (Polytechnical Univ., Budapest). Can. J. Phys., 45: 3915-22(Dec. 1967).

The mobilities of atomic and molecular helium ions were measured with an apparatus similar to that described by Biondi and Chanin, but with some modifications. Three species of ions were found. For the mobility of atomic ions a value of $\mu_0(He^+)$ = 10.6 ± 0.15 cm^2/V sec, for that of the two species of molecular ions $\mu_0(He_2^+)$ = 16.0 ± 0.28 cm^2/V sec, and $\mu_0(He_2^{+*})$ = 20.4 ± 0.26 cm^2/V sec have been obtained at 296°K. The three kinds of mobilities have been measured in the temperature range from 195 to 665°K. The mobility of the atomic ions decreased with the rise of temperature, while the mobilities of both molecular ions increased. The measurement results have been compared with those of theoretical calculations found in the literature. (auth)

13254 NUCLEAR MAGNETIC AND QUADRUPOLE RESONANCE AND THE EFFECTIVE FIELD ACTING ON THE ELECTRONS. Szigeti, B.; Tewary, V. K. (Univ. of Reading, Eng.). Phys. Lett., 26A: 112-13(Jan. 1, 1968).

It is shown that the linear Stark effect exhibited by nuclear magnetic and quadrupole resonance lines can give no new information about the effective field acting on the electrons. (auth)

13255 RESONANT CHARGE EXCHANGE IN ATOMIC COLLISIONS. Lichten, W. (Yale Univ., New Haven). Advan. Chem. Phys., 13: 41-54(1967).

Theoretical and experimental advances in this field are reviewed under the following headings: classical resonance; quantal resonance and charge exchange; effect of nuclear motion; quasi-resonant charge exchange damping; multiple ionization. (9 references). (UK)

13256 EXPERIMENTAL INVESTIGATION OF MULTIPLE PHOTON COMPTON PROCESSES. McGie, Michael Rushton. Davis, Calif., Univ. of California, 1967. 124p.

Thesis.

The double Compton and triple Compton processes were investigated experimentally. The cross section for the double Compton effect was measured at two sets of detector angles and was shown to be in agreement with theory. Existence of the triple Compton effect was verified and the cross section was measured. The double Compton experiments consisted in placing beryllium targets in a collimated beam of 662-keV gamma rays from a 6-curie ^{137}Cs source, detecting the emitted photons with NaI crystals fitted with photomultipliers, and recording the energy spectrum of coincident photons on a two-parameter pulse-height analyzer. Data were taken at two sets of detector angles. In both cases the two detectors were in a plane perpendicular to the gamma-ray beam. In one case the two detectors were separated by 90° and in the other case by 120°. The intensity of the incident gamma ray beam was measured by analyzing the spectrum of Compton scattered photons. Theoretical values for the double Compton cross section averaged over the large solid angles subtended by the detectors were determined by numerical integration for comparison with the experimental results. The discrepancies between the theoretical and experimental cross section values were within the estimated experimental error of about 10%. The total cross section for double Compton scattering with photon energies greater than 31.1 keV with the detectors separated by 90° was also measured. The result was 4.00×10^{-32} cm^2/sr^2. The corresponding theoretical value is 4.14×10^{-32} cm^2/sr^2. The discrepancy is 3.5%, which is within the estimated experimental uncertainty of 5%. The triple Compton experiment consisted of placing beryllium targets in the gamma ray beam and detecting triply coincident photons from the target. Three NaI crystals fitted with photomultiplier tubes were used to detect the photons. The detectors were in a plane perpendicular to the gamma-ray beam and 120° apart. The energy spectrum was recorded in a three-parameter array of $16 \times 16 \times 5$ channels by means of a two-parameter analyzer, five angle channel analyzers, and routing circuitry. Spectra were recorded with targets of three thicknesses. Random coincidences and true coincidences from sources other than the target were subtracted. The total number of counts in the triple Compton photopeak region was determined for each spectrum. The counting rate in this region was approximately proportional to target thickness, indicating that most of the counts were from triple Compton events. The cross section for occurrence of triple Compton events with a minimum photon energy of 13 keV was calculated to be 2.9×10^{-36} cm^2/sr^3 with an estimated uncertainty of 30%. (TSS) (Disser. Abstr.)

13257 POSITRON ANNIHILATION. Proceedings of the Conference held at Wayne State University on July 27–29, 1965. Stewart, A. T.; Roellig, L. O. (eds.) New York, Academic Press, 1967. 450p. $17.50; 140s. (CONF-650721).

Lengthy review articles on positron annihilation in various environments are presented. Recent developments in the field and present trends in research are discussed. (M.O.W.)

13258 EXPERIMENTAL STUDY OF SCATTERING IN ATOM–SURFACE COLLISIONS WITH ATOM ENERGIES OF THE ORDER OF 1 eV. Alcalay, Jack A. Los Angeles, Univ. of California, 1967. 132p.

Thesis.

Scattering of modulated argon atomic beams (with energies of the order of 1 eV and hydrodynamic speed ratios of the order of 7) from cleaved mica and from vacuum-deposited silver on cleaved mica consistently showed a multilobular pattern on a polar flux diagram. The scattering distributions are believed to be the first measured for beams with energies between 1 and 10 eV. Parameters varied during the experiments were (a) surface temperature and (b) time from deposition. The observed quasi-specular lobe bear a close resemblance to the distribution observed by other investigators who have scattered thermal energy beams from various surfaces and behave in some respects as predicted by one simplified collision model. Analyses of the data indicate that the detected molecules may have consisted of both scattered argon atoms and flash desorbed unknown species from the surface. This suggestion might be tested by mass-spectrometric differentiation of the scattered molecules. In addition to the aforementioned results, contributions in experimental and analytical techniques to scattering measurements are included. Basic concepts from the theory of linear operators are used to derive analytical relations between the TOF (time-of-flight) signals, the time-domain analogue of the steady-state beam speed distribution function and a gate function characterizing the modulation process. Sums and products of dynamic operators represent the sequence of dynamic perturbations imposed upon a molecular beam in the course of a scattering experiment. Central moment expansions of these sums and products in the time-domain provide a powerful simple and physically meaningful framework for determining the densities and the pertinent parameters of speed distribution functions of the incident and scattered flow fields. These concepts are applied also to a novel classification and characterization of ionization detectors (based on their dynamic effect in an experiment). A novel concept of calibration is developed and applied to the design, characterization and use of an Orbitron type detector. (Disser. Abstr.)

13259 CHERENKOV RADIATION IN DIELECTRIC AND PLASMA-FILLED INFINITE SPACE AND CAVITIES. Sasiela, Richard Joseph. Brooklyn, N. Y., Polytechnic Inst. of Brooklyn, 1967. 154p.

Thesis.

The radiation of uniformly moving charged particles in dielectric and plasma filled structures was studied. The structures studied are infinite space, waveguides, and cavities. The purposes of the study were as follows: (1) to determine how the energy radiated in plasma-filled cavities compares with that radiated in dielectric-filled cavities, and (2) to see if there is any way of analytically separating the energy due to Cherenkov radiation from the other sources of energy when metal structures are present. (TSS) (Disser. Abstr.)

13260 OPTICAL EMISSION PRODUCED BY PROTON AND HYDROGEN ATOM IMPACT ON NITROGEN AND HYDROGEN MOLECULES. Dahlberg, Duane Arlen. Missoula, Mont., Montana State Univ., 1967. 112p.

Thesis.

Optical emissions produced in collisions of protons incident on nitrogen and hydrogen molecules and hydrogen atoms incident on the same molecules were studied in the spectral region from 1200 to 6000 Å. Relative emission cross sections were measured in the energy range 10 to 130 keV. (TSS) (Disser. Abstr.)

Cosmic Radiation

Refer also to abstracts 12576, 13094, 13188, 13371, and 13648.

13261 (CEA-R-3177) ETUDE DU RAYONNEMENT GAMMA ENTRE 0,1 ET 1 MeV DANS L'ATMOSPHERE TERRESTRE. (Study of Gamma Radiation Between 0.1 and 1.0 MeV in the Earth's Atmosphere). Boclet, Daniel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 94p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

The present work is devoted to some of the particular problems arising in the detection and localization of sources of gamma radiation situated outside the Earth's atmosphere. These weak sources can only be detected and localized if care is taken to eliminate gamma and particle radiations coming from other sources in the Earth's atmosphere and in space. In order to separate the various sources of background noise, generally much stronger than the radiation under study, use is made of a directional detector whose characteristics are determined as described in the first part of the following report. The closest diffuse source considered is that constituted by the Earth's atmosphere. Its detailed study will make it possible both to eliminate its effect when sources outside the Earth are to be measured, and to predict the amount of secondary gamma radiation emitted by the same process in other celestial bodies, the moon in particular. (auth)

13262 (RPP/A-30) TRACKS DUE TO ELECTRON SHOWERS OBSERVED IN MICA. Russell, F. M. (Rutherford High Energy Lab., Chilton (England)). Nov. 1, 1967. 7p. Dep. CFSTI, UK.

Evidence has been found which suggests that tracks from electron showers due to electromagnetic interactions of muons deep underground can be recorded in muscovite mica. (auth)

13263 (RPP/A-34) RUTHERFORD SCATTERING IN MUON TRACKS IN MICA. Russell, F. M. (Rutherford High Energy Lab., Chilton (England)). Dec. 1967. 4p. Dep. CFSTI, UK.

The hypothesis that certain line markings in mica are caused by muons during a sensitive phase of the crystal is strengthened by the observation of Rutherford scattering of the tracks at large angular deviations. (auth)

13264 DIRECTIONS OF VIEWING OF GROUND-BASED NEUTRON MONITORS IN AN EARTH-CENTERED CO-ORDINATE

SYSTEM. Tanskanen, Pekka J. (National Research Council of Canada, Ottawa). Ann. Acad. Sci. Fenn., Ser. A VI, No. 257, 1-9(1967).

A geometrical presentation has been given of the asymptotic directions of "viewing" of ground-based cosmic-ray neutron monitors. Formulas from which these directions can be calculated are given for any station for which the asymptotic directions have been worked out. (auth)

13265 SPARK CALORIMETER STUDY OF MUONS AT 200 MWE. Bibilashvili, M. F.; Barnaveli, T. T.; Grubelashvili, G. A.; Muradova, N. A.; Khaldeeva, I. V. (Inst. of Physics, Tbilisi, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1563-4 (Sept. 1967). (In Russian).

Using in 1965 the "small" spark calorimeter and in 1966 the large spark calorimeter of the Underground Laboratory of the Institute of Physics of the Georgian SSR Academy of Sciences, groups of cosmic-ray muons at 200 mwe were investigated. The large spark calorimeter consists of 8 trays of spark chambers separated by 5 cm of lead, each tray being separated into four independent parts of 2.25 m^2 area each. During 542 hours of on-time in 1966 there were recorded 37 groups of parallel-traveling penetrating particles. The flux I of groups with more than N particles is presented graphically for N from 2 to over 40. This spectrum is given approximately by $I = AN^{-\gamma}$ with $\gamma = 1.1$ and $A = 0.104$ group/m^2 hour. The 1965 data, recorded with the small spark calorimeter, fit well on this same spectrum. The exponent in the angular distribution of the groups was 4.5 ± 1.5. Comparison of these data with those of S. Higashi et al. (Nuovo cimento, 5, 597 (1957)) indicates that the energy of the muons in a group is independent of the number of particles in the group and is close to the mean energy of muons in extensive air showers at the corresponding depth. The distribution of the distances between the particles in groups indicates that this characteristic alone is not a reliable criterion for distinguishing groups; the energy carried by the group particles does provide such a criterion. (ATD)

13266 INVESTIGATION OF THE PENETRATING COMPONENT OF THE COSMIC RAYS AT 130 MWE. Aglamazov, V. A.; Gedevanishvili, L. D.; Kazarov, R. E.; Kotov, Yu. D.; Keshelashvili, D. Sh.; Kuridze, R. V.; Logunov, V. M.; Sakvarelidze, I. I. (Inst. of Physics, Tbilisi, USSR. Moscow Engineering Physics Inst.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1561-2(Sept. 1967). (In Russian).

The authors employed an ionization calorimeter with an added hodoscopic system to investigate penetrating cosmic-ray particles (muons) traveling in pairs at a depth of 130 mwe underground. In 1229 hours of on-time there were observed 35 events (some 2% of the total number of observed ionization bursts due to single muons) which, because of the distribution of the ionization in the ionization calorimeter and the triggered hodoscopic counters, had to be ascribed to the simultaneous passage of at least two penetrating particles. The average distance between the particles of the pairs producing these events was 1.5 m, and the angular distribution of the muon pairs could be represented by the equation $N(\Theta) = (\cos\Theta)^n d(\cos\Theta)$ with $n = 0.35$. The exponent in the energy spectrum of the pair of muons was $\gamma = 1.3 \pm 0.4$, which is close to the value of the exponent in the energy spectrum of muons in extensive air showers. The ratio of the ionizations produced by the two particles of a pair was approximately uniformly distributed over the interval from 0 to 1, with an average value of 0.6. During 370 hours of on-time there was in operation surface equipment with which the magnitudes of the showers accompanying underground ionization bursts could be determined. During this time there were observed no ionization bursts due to muon pairs, and 12 ionization bursts due to single muons and accompanied by extensive air showers. The average magnitude of the showers accompanying these bursts was 6.3×10^4 particles. It is suggested that the probability that so small a shower be accompanied by muon pairs is low, but the statistics are too poor to permit this suggestion to be regarded as a conclusion. (ATD)

13267 INVESTIGATION OF THE ENERGY AND ANGULAR DISTRIBUTION OF HIGH-ENERGY MUONS. Kazarov, R. E.; Kotov, Yu. D.; Kuridze, R. V.; Logunov, V. M. (Inst. of Physics, Tbilisi, USSR. Moscow Engineering Physics Inst.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1558-60(Sept. 1967). (In Russian).

Earlier investigations of the burst spectrum of 0.3- to 2.0-TeV cosmic-ray muons at 130 mwe underground were continued. The 3×3-m^2 ionization calorimeter employed in the earlier work, consisting of 6 trays of ionization chambers separated by 8 cm of iron, was supplemented by a hodoscopic system consisting of 64 hodoscopic groups with a sensitive area of 0.1 m^2 each above the calorimeter and 56 groups below it. In 1229 hours of on-time there were recorded 517 events in which the direction of the incident muon could be determined with the hodoscopic system and an ionization exceeding that due to 100 vertical relativistic particles was produced in at least one calorimeter tray. The angular distribution of the muons initiating these events agreed with that calculated from the geometric characteristics of the instrument on the assumption of an isotropic distribution of the incident particles. The muon energy spectrum for muon energies above 150 BeV derived from these events agreed with the spectrum given by Wolfendale (Proc. Internat. Conf. Cosmic Rays, Jaipur, 5: (1963)) after conversion to a depth of 130 mwe. Correction for threshold effects brought the present spectrum into agreement with Wolfendale's over the full energy range from 50 to 1000 BeV. (ATD)

13268 INVESTIGATION OF THE PENETRATING COMPONENT OF HIGH-ENERGY COSMIC RADIATION AT 20 AND 40 MWE UNDERGROUND. Vernov, S. N.; Vedeneev, O. V.; Nechin, Yu. A.; Khrenov, B. A.; Fomin, Yu. A.; Silaev, A. A.; Khristiansen, G. B. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1555-7(Sept. 1967). (In Russian).

The fluxes of penetrating particles recorded at 20 and 40 mwe underground during 1966 with the Moscow State University installation are discussed and the data are compared with the similar data recorded in 1965. The particle detectors consisted of $25 \times 25 \times 12.5$-cm lead-shielded ionization chambers, and hodoscopic counters with which the direction of motion of the particle could be determined when the zenith angle did not exceed 45°. There were 48 ionization chambers at 20 mwe underground and 240 chambers at 40 mwe. The exponent γ in the expression $n^{-\gamma}$ for the flux of particles producing ionization exceeding that produced by n relativistic particles was the same at both levels; γ was 2.0 for the particles coming in with zenith angles less than 45°, and 1.9 for the particles coming in at all angles. A slight difference between the values of γ for the 1965 and 1966 data is ascribed to the difference between the thresholds at which the ionization chambers were operated in the two years, the threshold having been about 100 relativistic particles in 1965 and 40 relativistic particles in 1966, and it is argued that the 1966 threshold, which is about 4% of the total ionization at the low end of the recorded spectrum, is sufficiently low to not have significantly distorted the spectrum. The absolute flux of particles producing more ionization than that produced by 10^3 relativistic particles was the same at both levels (within the 10% statistical error); the flux of particles with zenith angles below 45° was $(2.15 \pm 0.20) \times 10^{-2}$ particle/hour m^2 sterad. It is concluded that the penetrating particles are muons. (ATD)

13269 ANALYSIS OF PHOTOEMULSION DATA ON NUCLEAR INTERACTIONS AT ENERGIES OF $\geq 10^{12}$ eV. Mensovich, M.; Gerulya, E. (Inst. for Nuclear Research, Krakow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1398-1408(Sept. 1967) (In Russian).

Nucleon interactions with emulsion nuclei at energies $\geq 10^{12}$ eV were investigated. The interactions were observed in two large emulsions (80 l in volume) stacks during cosmic flights. Only geometrically clear shower positions with a shower length exceeding 2 mm in one plate and total shower length in the stack exceeding 20 cm were considered. It was found that it is impossible to describe multiple formation of energetic cosmic particles, by a single statistical–hydrodynamic process. A more natural approach would be to consider two types of interactions, peripheral and central. The central interactions can not be obtained by the emulsion method. The inelastic peripheral interactions at 1 to 10 TeV may be described by a fireball model (with possible baryon excitation) considering that the fireballs are short-life real bodies with baryon number B = 0. The discovery of asymmetric showers with fireballs also tends to confirm the reality of fireballs. Results of Japanese group studies of large transverse fireball pulses may also confirm the existence of fireballs. Otherwise, the fireball model may be considered only a formal description and the discovery of peripheral interactions and the large cross section of the interaction are the only important data obtained by the emulsion method. (R.V.J.)

13270 ANGULAR DISTRIBUTION OF SECONDARY PARTICLES IN SHOWERS. Knizhnikova, L. A.; Mishchenko, L. G.; Murzin, V. S.; Sarycheva, L. I. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1412-13(Sept. 1967). (In Russian).

Angular distribution of nuclear-active particles in graphite was measured according to the parameter $\lg(\gamma_s/\gamma_c)$ using a device consisting of a Wilson chamber, ionization calorimeter, and hodoscopic counters. The recorded events are classified on the basis that symmetric showers are described by $0.3 < \lg(\gamma_s/\gamma_c) < 0.1$, asymmetric backward showers by $\lg(\gamma_s/\gamma_c) \leq -0.3$, and asymmetric forward showers by $\lg(\gamma_s/\gamma_c) \geq 0.1$. Characteristics of each class of shower are tabulated. (R.V.J.)

13271 CHARACTERISTICS OF THE PROCESS OF MULTIPLE PARTICLE GENERATION AT ENERGIES OF 100 TO 1000

GeV. Guseva, V. V.; Dobrotin, N. A.; Zelevinskaya, N. G. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1414-16(Sept. 1967). (In Russian).

Multiple meson generation was studied as functions of the initial energy. Experimental data obtained with LiH targets for 73 interactions of 20- to 2000-GeV cosmic particles recorded by the Pamir and Tyan-Shan' installation were investigated. The data were separated into groups according to E_0 = 70 to 150, 150 to 200, 250 to 600, and 1000 to 200 GeV. The number of showers at the above energies were 23, 20, 22, and 8, respectively. The mean multiplicity values of charged particles were calculated for each energy group. (R.V.J.)

13272 MEASUREMENTS WITH THE PROTON 1 AND PROTON 2 SATELLITES OF THE CROSS SECTION FOR INELASTIC INTERACTION OF 10- TO 1000-BeV PROTONS WITH CARBON NUCLEI. Basilova, R. N.; Grigorov, N. L.; Nesterov, V. E.; Rapoport, I. D.; Savenko, I. A.; Skuridin, G. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1450-2(Sept. 1967). (In Russian).

The Proton 1 and Proton 2 satellites carried type SEZ-14 ionization calorimeters with which the cross section for inelastic interaction of 10^{10} to 10^{12} eV protons with carbon nuclei was measured The inelastic interaction cross section was measured by the "knock out of the beam" method, recording the number of singly charged particles that traversed a 30.6 g/cm^2 graphite absorber without interacting, traversed a polyethylene absorber, or no absorber, and liberated more than a fixed amount of energy in the calorimeter. The SEZ-14 instrument is built in two sections, which operated independently and served to check each other. Weighted averages of the data from both satellites showed that the cross section for inelastic interaction with carbon nuclei of 24-, 60-, 170-, 500-, and 1100-BeV protons is 221 ± 3, 227 ± 4, 242 ± 3, 270 ± 5, and 256 ± 15 mb, respectively. These data may be compared with earlier obtained cross sections of 218 mb for 24-BeV artificially accelerated protons and 254 ± 7 mb for 21.5-BeV protons. When the cross section for "quasi-elastic" scattering, which was counted as elastic scattering in the Satellite measurements, is subtracted from the earlier results, a difference of 221 mb is found, which is in good agreement with the satellite data. (ATD)

13273 A METHOD FOR DETERMINING THE ALTITUDE OF MUON PRODUCTION IN EXTENSIVE AIR SHOWERS. Shomodi, A. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1512-16 (Sept. 1967). (In Russian).

A method is proposed for determining the altitude of muon production in extensive air showers, based on the separation of positive and negative muons as a result of their motion through the geomagnetic field. To apply the proposed technique one must determine the position and direction of the shower axis as well as the separate distributions about it of positive and negative muons of different energies. On the assumption that all the muons of a given energy are produced at the same height, there is derived an integral equation relating the observed distributions to the altitute of muon production. Similar equations can be derived for other assumptions concerning the distribution of muon production heights. The accuracy with which this equation can be solved is discussed and it is concluded that if 10 BeV muons are produced at a height of 4 km above the observation level, that height can be determined with an error of 200 to 500 m from measurements of 2000 muons at a distance of 100 m from the shower axis. It is not absolutely essential to measure all the quantities mentioned above, but the accuracy of the muon production altitude determination will be much lower if some of them are left unmeasured. An experiment of the discussed type is under way in England, but the results are not yet available. (ATD)

13274 HIGH-ENERGY NUCLEAR ACTIVE PARTICLES AND EXTENSIVE AIR SHOWERS AT SEA LEVEL. Murzina, E. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1517-19(Sept. 1967). (In Russian).

Data recorded at sea level over a period of years at the Super-high Energy Laboratory of Moscow University were used to derive magnitude (total particle number) distributions of the extensive air showers accompanying high-energy nuclear active particles of different energies. The investigation was undertaken because similar studies of data recorded at mountain altitudes at Pamir surprisingly revealed that whereas a standard interaction acts with an inelasticity of 0.5 and an interaction free path of 90 g/cm^2 can account for the magnitudes of the showers accompanying 1.3 to 2.6 TeV nuclear active particles, the showers accompanying nuclear-active particles in the 5 to 10-TeV energy range are larger than can be accounted for by the standard interaction. In the present work magnitude distributions were derived for the showers accompanying nuclear active particles in ranges 2 to 4, 4 to 8, 8 to 16, and 16 to 32 TeV, and are compared with the distributions calculated for the standard interaction. The energy spectrum of the nuclear-active particles observed in this work followed a power law with an exponent of 1.7 ± 0.1. With the aid of some corrections it was possible to reconcile the theoretical and experimental magnitude distributions of the showers accompanying nuclear-active particles with energies below 8 TeV, but the higher-energy nuclear-active particles were accompanied by larger showers than would be expected on the basis of the standard interaction, and the widths of the magnitude distributions of these showers were smaller than would be expected. It is concluded that the character of the nuclear interaction changes at an energy in the vicinity of 8 TeV, the relative energy transfer to the electron–photon component being greater in the higher-energy interactions than in the lower-energy ones. (ATD)

13275 NEW DATA ON PARTICLE GROUPS AT 40 MWE UNDERGROUND. Vernov, S. I.; Nechin, Yu. A.; Khrenov, B. A.; Khristiansen, G. B. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1520-2(Sept. 1967). (In Russian).

Earlier studies of the authors of particle groups near the axes of extensive air showers at 40 mwe underground were continued. During an on time of about 1000 hours there were recorded 25 showers with total numbers of particles ranging from below 10^4 to 5×10^5 in which there were observed groups of 5 or more muons at 40 mwe underground. In these showers 504 muons traversed the ionization chamber trays, and 13, 8, and 2 of them produced bursts equivalent to more than 50, 100, and 1000 relativistic particles, respectively. Single particles producing ionization bursts were selected according to two criteria: (a) a single particle produced a burst equivalent to more than 1000 relativistic particles; or (b) a single particle produced at least three successive bursts, each equivalent to more than 5 relativistic particles. In 1900 hours of on time with a sensitive area of 4.5 m^2 there were observed 290 type (b) events, in 44 of which there were observed 4 bursts equivalent to more than 5 relativistic particles. Of these 290 events, 95, 10, and 2 were accompanied by bursts equivalent to more than 100, 500 and 1000 relativistic particles, respectively. Energy and lateral distributions of type (a) and (b) particles were derived. The particles have energies of the order of 10^3 BeV and a lateral distribution of the $1/r^n$ type with n = 1.3 ± 0.3. Type (b) events were accompanied by very small air showers having on the average only 1000 particles at ground level. The shower (burst) producing capability of these particles is about the same as that of the particle group. (ATD)

13276 SEARCH FOR NEUTRAL PARTICLES AT 40 MWE UNDERGROUND. Vernov, S. N.; Khrenov, B. A.; Khristiansen, G. B. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1523-5(Sept. 1967). (In Russian).

Neutral particles capable of initiating electron or nuclear showers in cosmic rays at 20 mwe underground were sought. The investigation was undertaken because of recent indications that there may be penetrating particles other than muons in cosmic rays, and the possibility that at least some of these particles may be neutral. Four 100 × 100 × 10-cm spark chambers mounted one above the other were employed in the search. Between the two upper and the two lower spark chambers there were 16 cm of lead, 1 cm of iron, and a tray of Geiger counters, and below the lowest spark chamber there was a 7-cm-thick 70-cm-diameter circular scintillation counter. The spark chambers operated when the scintillation counter recorded the equivalent of more than about 7 vertical relativistic particles and at least one of the Geiger counters tripped. The equipment had a sensitive area of 0.36 m^2 and a geometric factor of 0.38 for electron showers and 0.1 for nuclear showers. During the 1200 hours of on-time there were recorded 2903 electron showers and 28 nuclear showers of which 2148 electron showers and 25 nuclear showers were certainly initiated by charged particles and the remaining showers were possibly initiated by charged particles. No shower of any kind was observed that could not have been initiated by a charged particle. (ATD)

13277 FLUCTUATIONS OF THE ENERGY FLUX OF NUCLEAR-ACTIVE PARTICLES IN EXTENSIVE AIR SHOWER CORES. Vedeneev, O. V.; Mandritskaya, K. V.; Nechin, Yu. A.; Kristiansen, G. B. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1526-7(Sept. 1967). (In Russian).

The distributions of extensive air showers having fixed numbers N_e of electrons or fixed number N_μ of muons with respect to the energy flux F in the nuclear-active component in the shower core were investigated. The experimental material consisted of 70 extensive air showers recorded during 1963 and 1964 with the Moscow State University installation and selected by the criteria that N_e exceed 5×10^4, N_μ exceed 3×10^3, the zenith angle of the shower axis be less than 30°, and the shower axis pass within 5 m of the center of the nuclear-active particle detector. Histograms are presented showing the distributions with respect to log (F) of showers for which the average value of N was 2.4×10^5, and of showers

for which the average value of N_μ was 9×10^3. These distributions are very broad, F ranging over more than two orders of magnitude. There are also presented scatter plots of log (F) versus log (N_e) and versus the age parameter s. Both these scatter plots show appreciable correlation: log (F) tends to increase with increasing log (N_e) and with decreasing s. The results are in good agreement with earlier findings of Vernov et al. and are in qualitative agreement with the results of theoretical calculations (ATD)

13278 FLUCTUATIONS OF DIFFERENT COMPONENTS OF EXTENSIVE AIR SHOWERS AT SEA LEVEL. Abrosimov, A. T.; Atrashkevich, V. B.; Belyaeva, I. F.; Kulikov, G. V.; Mandritskaya, K. V.; Solov'eva, V. I.; Khrenov, B. A.; Khristiansen, G. B. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1528-9(Sept. 1967). (In Russian).

Earlier studies of the authors of the distribution of extensive air showers recorded with the complex installation of Moscow State University were continued. Data are presented on the distributions of showers whose axes have zenith angles less than 30°, with respect to number N_e of electrons, number N_μ of high-energy muons (recorded at 40 mwe underground), and age parameter s. The average value $\overline{N}_\mu$ of N_μ for showers with N_e close to a fixed value was found to be $\overline{N}_\mu = AN_e^n$, with $A = 0.42 \pm 0.04$ and $n = 0.78 \pm 0.015$, and the average value $\overline{N}_e$ of N_e for showers with N_μ close to a fixed value was found to satisfy the equation $N_\mu = B\overline{N}_e^m$ with $B = 0.62 \pm 0.09$ and $m = 0.78 \pm 0.025$. No significant difference was found between the distributions with respect to $N_\mu/\overline{N}_\mu$ or s of the showers for which N_e was greater than 8×10^5 and the corresponding distributions of the showers for which N_e was less than 8×10^5. The present data confirm earlier findings. (ATD)

13279 FLUCTUATIONS OF THE CHERENKOV FLASH ACCOMPANYING EXTENSIVE AIR SHOWERS. Nesterova, N. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1530-2(Sept. 1967). (In Russian).

The author has reexamined the data on the Cherenkov flash accompanying extensive air showers recorded in 1957 at Pamir at an altitude where the atmospheric pressure was 650 g/cm². There were found 1300 showers for which the intensity Q of the Cherenkov flash had been measured and the distance R from the point of observation to the intersection of the shower axis with the level of observation was between 60 and 180 m. The number N of particles in these showers ranged from 5×10^5 to 10^7 and the zenith angles of their axes ranged from 0 to 50°. The half-width of the distribution of all the showers with respect to $(Q/N)/(\overline{Q}/N)$ was only 0.35, but there were appreciable numbers of showers with values of $(Q/N)/(\overline{Q}/N)$ exceeding 2, and values as great as 3.2 were found. The distribution of showers with $N = 10^6$ with respect to Q/N is compared with several theoretical curves based on different models of extensive air shower development and the assumption that $Q/N = CA^\alpha$, where C is a constant, A is the mass number of the primary cosmic-ray nucleus that gave rise to the shower, and $\alpha = 0.2 \pm 0.03$. The observed distribution is narrower than the calculated ones in the region of low deviations of Q from its mean, but the observed frequency of large positive deviations is higher than the calculated frequency (ATD)

13280 RADIO PULSES FROM EXTENSIVE AIR SHOWERS AT 520 MHz. Fegan, D. J.; Slevin, P. J. (Univ. Coll., Dublin). Nature (London), 217: 440-1(Feb. 3, 1968).

Radio pulses at frequencies <100 MHz have been detected in association with extensive air showers by many workers. Current theories do not predict a detectable flux of radio frequency power at >100 MHz. The highly idealized model of Kahn and Lerchl imposes a limiting frequency of ~75 MHz, because of coherence conditions, while Colgate predicted a maximum emission at 1 HMz. Because of the nature of the theoretical models used, however, and the possibility of other mechanisms contributing strongly in the uhf region of the spectrum, it was deemed desirable to make a study at >100 MHz. The experimental technique adopted is described, and the results analyzed and discussed. It was concluded that, using a radio-particle coincidence technique, tentative evidence was obtained for uhf radio emission from extensive air showers, this emission being consistent with an incoherent process. Possible mechanisms are radio bremsstrahlung from delta-ray electrons, isotropic recombination radiation from atmospheric atoms and molecules, and the radiative Coulomb scattering of low-energy shower electrons. (UK)

13281 ON THE DENSITY FLUCTUATIONS OF THE CHERENKOV RADIATION IN GIANT AIR SHOWERS AT SEA LEVEL. Kalmykov, N. N. (Moscow State Univ.). Yadern. Fiz., 6: 1019-22(Nov. 1967). (In Russian).

Fluctuations of the space distribution function of the Cherenkov radiation in extensive air showers at sea level are calculated by means of the Monte Carlo method. The fluctuations are shown to be small at distances of about 200 m from the shower axis. An upper bound is given for the fluctuations of the total flux of the Cherenkov radiation in a shower with a fixed primary energy. (auth)

13282 DIFFUSION OF SOLAR COSMIC RAYS AND THE POWER SPECTRUM OF THE INTERPLANETARY MAGNETIC FIELD. Nathan, K. V. S. K.; Van Allen, J. A. (Univ. of Iowa, Iowa City). J. Geophys. Res., 73: 163-4(Jan. 1, 1968).

Van Allen and Krimigis find that solar electrons diffuse through the interplanetary medium at a rate that is similar to that of protons of the same velocity, despite the disparity by a factor of 2×10^3 in their respective magnetic rigidities, and they suggest that this fact serves to extend knowledge of the structure of the interplanetary magnetic field to much smaller scale than has been measured by Coleman. This suggestion is developed quantitatively in the framework of Roelof's theory. It is found that the power spectrum of the interplanetary magnetic field varies inversely as the square of the frequency f in the range $2.7 \times 10^{-4} < f < 0.5$ cps. (auth)

13283 COSMIC-RAY NEUTRON MONITOR YIELD FUNCTIONS, GROSS TRANSFORMATION, AND NUCLEONIC COMPONENT MEAN FREE PATHS. Keith, J. E. (Sandia Lab., Albuquerque, N. Mex.); Peterson, R. W.; Tjonaman, R. L.; Wang, J. R. J. Geophys. Res., 73: 353-60(Jan. 1, 1968). (LA-DC-8968).

The differential response function is derived using neutron pile latitude surveys made in June 1965 at 307 g/cm² over the geographic latitude ranges 59°S to 17°N and 30°N to 53°N. The specific yield function is obtained from the differential response function and the 1965 differential primary spectrum derived from satellite and balloon data. When the Gross transformation is applied, the resultant differences in differential response varying from 17% at 15.0 GV to 43% at 1.5 GV are obtained. Differences from 21% to 44% are also found for the specific yield function in the rigidity range from 7 to 1.5 GV. At large atmospheric depth, a limit is set for the applicability of the Gross transformation. Finally, new measurements of the nucleonic component mean free paths at 307 g/cm² during solar minimum in the rigidity ranges 1 to 14 GV are included. (auth)

13284 THE AVERAGE AND MAXIMUM DISTANCE OF EAS AXIS FROM THE APPARATUS AS A FUNCTION OF SHOWER SIZE AND AGE PARAMETER. Jatczak, Jerzy (Univ., Lodz, Poland). Nukleonika, 12: 1113-22(1967). (In Polish).

The analytical form of radial distribution of EAS registration frequency is given. The value of average distance of EAS axis from the apparatus was found as a function exponent γ, parameter s, and the number k of the G-M counter. The dependence of maximum distance r_N of showers axis from the apparatus on the total number of particles was determined. (auth)

13285 A CALCULATION OF THE FLUX AND ENERGY SPECTRUM OF SECONDARY ELECTRONS AT HIGH ALTITUDES IN THE ATMOSPHERE. Verma, Satya Dev (Univ. of Chicago). Proc. Indian Acad. Sci., Sect. A, 56: 125-43(Sept. 1967).

Calculations were carried out to determine the flux and energy spectra of secondary electrons which are produced by the cosmic radiation in the upper layers of the atmosphere. The calculations are valid to an atmospheric depth of about 10 g/cm². Electron spectra are presented for different depths and locations where measurements of the electron flux have been carried out: Ft. Churchill, Manitoba; Sioux Falls, South Dakota; Palestine, Texas; and Hyderabad, India. The calculations are compared with observed electron fluxes during the ascents of balloon flights. (auth)

13286 MEASUREMENT OF DIFFUSE X-RAY BACKGROUND OF OUTER SPACE IN THE ENERGY REGION 1 TO 1.5 keV. Mandelstam, S. L.; Tindo, I. P. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 251-3(Oct. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 796-9(Oct. 15, 1967).

Measurements were made of the diffuse x-ray background in the 1- to 1.5-keV region from outer space. (M.O.W.)

Direct Energy Conversion

Refer also to abstracts 13311, 13574, and 13580.

13287 (SC-T-68-1503) CONVERSION OF EXPLOSIVE ENERGY INTO ELECTROMAGNETIC ENERGY. Bernard, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated by Marcel I. Weinreich

(Sandia Corp., Albuquerque, N. Mex.), from report CEA-Bib-85. 58p. Dep. CFSTI. JCL $6.60 fs, $2.03 mf.

The following topics are discussed: (1) compressions of the magnetic field by explosives, (2) ferromagnetic and ferroelectric transducers, and (3) magnetohydrodynamic generators served by an explosive. (M.O.W.)

13288 THERMODYNAMIC ASPECTS OF CLOSED-CYCLE MHD CONVERSION. Azalbert, Jean-Paul; Zettwoog, Pierre (CEA, Paris). Entropie, No. 17, 59-70(Sept.-Oct. 1967). (In French).

Thermal power stations designed for the production of electricity are reaching a high degree of technical perfection. It is assumed that improvements in conversion efficiency are still possible, although slow and limited; they will only be the result of constant, costly technological efforts. In order to make a radical change in prospects for improving efficiency, a new conversion principle is needed. Direct conversion of thermal energy into electrical energy by magnetohydrodynamics is being actively studied with this in view. The association of the MHD converter with conventional heat machines is considered here. Various types of association are chosen. Their characteristics are described and their performances calculated. From these results as a whole, a general view is obtained of the overall progress which the MHD generation principle could bring to the conversion efficiency of power stations. (auth)

13289 VARIABLE-REGIME THERMIONIC CONVERTERS. Landrot, Jean-Pierre (Centre d'Etudes Nucleaires, Saclay, France). Entropie, No. 17, 71-8(Sept.-Oct. 1967). (In French).

The principle of the thermionic converter is reviewed. Its operation is defined by the values of four independent parameters: thermal power input-electrical load resistance-cesium pressure—thermal impedance of the cooling circuit associated with the collector. Any disturbance in one of these parameters brings about a change of thermal equilibrium in the converter and reacts on the electrical power generated. Attention is then turned to the main transitory operations or a laboratory converter and of a converter with nuclear heating. The study enables a critical examination to be made of the various methods of taking readings of characteristics; it shows that, for small variations in the parameters, the converter's response is independent of the method of heating. It also enables the main general principles for the control and regulation of a thermionic reactor to be stated. (auth)

13290 CALCULATION OF A BOUNDARY LAYER AT THE INSULATING WALL OF THE MHD-CHANNEL. Apollonskii, S. M.; Kos'kin, Yu. P. (Naval-Military Engineering Academy, Leningrad). Inzh.-Fiz. Zh., 13: 536-41(Oct. 1967). (In Russian).

Mathematical expressions are presented for calculation of parameter distribution in a laminar compressible boundary-layer on the insulating wall in the MHD channel when crossed magnetic and electric fields exist and the change of electromagnetic load coefficient is accounted for. (auth)

13291 EFFECT OF THE MAGNETIC REYNOLDS NUMBER IN THE INDUCTION STRIATED-FLOW MHD GENERATOR. Milewski, J. (Inst. of Fluid-Flow Machines, Danzig). Bull. Acad. Pol. Sci., Ser. Sci. Tech., 15: 753-60(1967).

An idealized study was made to determine the effect of magnetic leakages, characterized by magnetic Reynolds number, on the generator operation. The conclusion was made that the effect of magnetic leakages was immaterial as regards any possible practical application. (M.O.W.)

13292 ROLE OF LITHIUM IN DAMAGE AND RECOVERY OF IRRADIATED SILICON SOLAR CELLS. Wysocki, Joseph J. (AED Physical Research Lab., Princeton, N. J.). Contract NAS5-10239. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 103-9(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Lithium plays a role in the degradation and recovery of diffusion length in lithium-doped silicon p/n solar cells irradiated with 1-MeV electrons. Salient experimental results are that (1) the diffusion length degrades when these cells are irradiated at a fast rate; (2) the time constant for recovery of diffusion length decreases with lithium concentration, and increases with fluence, as $\phi^{\frac{1}{2}}$; and (3) recovery is a temperature-sensitive process with an activation energy of (0.61 ± 0.10) eV. These results suggest the following model for the damage and recovery process. Degradation of diffusion length occurs when radiation-induced vacancies pair with lithium and other available impurities to form immobile, negatively charged recombination sites. These sites are formed at a rate governed by the irradiation rate and the high vacancy mobility. Unpaired lithium ions diffuse to, and pair with, these recombination sites, reducing their cross sections to very low values. Thus, recovery of diffusion length occurs. Recovery follows diffusion-limited kinetics in which the reacting species are of unequal concentrations. The capture radius of the recombination site for a lithium ion is proposed to decrease with fluence as $\phi^{-\frac{1}{2}}$ to achieve better accord between theory and experiment. (auth)

13293 ON THE SELECTION OF THE TYPE OF FLOW IN A MHD GENERATOR WITH SEGMENTED ELECTRODES. El'kin, A. I.; Yantovskii, E. I. Izv. Akad. Nauk SSSR, Energ. Transp., No. 6, 107-13(Nov.-Dec. 1967). (In Russian).

Plasma propagation in a channel with series coupling of segmented electrodes (with fixed electrical field direction in the absence of a longitudinal field) was studied in the quasi-one-dimensional approximation. Effective energy transformation in the MHD generator with a single electrical load is discussed. (tr-auth)

13294 APPLICATION OF MAGNETOHYDRODYNAMICS IN ENERGY CONVERSION. II. Ponthus, Pierre. Entropie, No. 15, 78-85(May-June 1967). (In French).

The equations describing the phenomena of MHD conversion presented in Part I are simplified for rapid application to problems involving elementary models of MHD converters. The electric and thermodynamic performances of some elementary generators are analyzed and compared. (auth)

13295 APPLICATION OF MAGNETOHYDRODYNAMICS IN ENERGY CONVERSION. I. Ponthus, Pierre. Entropie, No. 13, 19-26(Jan.-Feb. 1967). (In French).

The conversion of energy by magnetohydrodynamic methods continues to be the object of theoretical and experimental research. The general MHD equations are reproduced both in integrable form in consideration of their application to varied geometries and in differentiated form in order to allow local studies. Research on the conductivities of gases for possible use in MHD converters is summarized. (A.G.W.)

13296 ADVANCED PROPULSION CONCEPTS. Proceedings of the Fourth Symposium, April 26–28, 1965, Palo Alto, California. New York, Gordon and Breach, Science Publishers, Inc., 1966. 311p. (CONF-650416-(Vol.2)).

Separate abstracts were prepared for 12 of the papers included. (M.O.W.)

For abstracts of individual papers see: 13297–13306, 13431, and 13443.

13297 SUBORBITAL FLIGHT TESTING OF ELECTRIC PROPULSION SYSTEMS. Davis, Jack (Electro-Optical Systems, Inc. [Pasadena, Calif.]. pp 1-18 of Advanced Propulsion Concepts. New York, Gordon and Breach, Science Publishers, Inc., 1966.

From 4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif. See CONF-650416-(Vol.2).

Test flights were conducted on the complete electric propulsion system: a cesium contact ion engine, power conditioning, and instrumentation and controls. The results are discussed. (M.O.W.)

13298 RESULTS FROM SERT I ION ROCKET FLIGHT TEST. Cybulski, R. J.; Shellhammer, D. M.; Lovell, R. R.; Domino, E. J.; Kotnik, J. T. (Lewis Research Center, Cleveland). pp 21-61 of Advanced Propulsion Concepts. New York, Gordon and Breach, Science Publishers, Inc., 1966.

From 4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif. See CONF-650416-(Vol.2).

The SERT I (Space Electric Rocket Test) spacecraft was launched at 0553:15 EDT on July 20, 1964, from Wallops Island, Virginia. Two ion thrustors were programed to operate sequentially during the flight. One of these, a contact ion thrustor, could not be started because of a high-voltage electrical short circuit. The other thrustor, which was of the electron-bombardment type, operated as expected for a total of 31 minutes and 16 seconds during the flight. The primary flight objective of confirming neutralization of a high-perveance ion beam was attained. Ion beam thrust was measured with three independent thrust measuring systems. All voltages, currents, and other operating characteristics of the electron-bombardment thrustor were close to the nominal values obtained in previous vacuum tank tests. Telemetry data indicated no noticeable radio-frequency interference generated by the ion beam. Furthermore, all commands between the ground transmitter and spacecraft were transmitted and executed without interference. (auth)

13299 ALFVEN WAVE PROPULSION. Gross, R. A. (Columbia Univ. [New York]). Contract AF49(638)-1254. pp 65-9 of Advanced Propulsion Concepts. New York, Gordon and Breach, Science Publishers, Inc., 1966.

From 4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif. See CONF-650416-(Vol.2).

A general review of the concepts involved in Alfvén wave propulsion is presented. (M.O.W.)

13300 COLLOID PROPULSION; STATE OF THE ART AND REVIEW OF CURRENT RESEARCH. Hendricks, Charles D. (Univ. of Illinois [Urbana]). pp 91-102 of Advanced Propulsion Concepts. New York, Gordon and Breach, Science Publishers, Inc., 1966.

From 4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif. See CONF-650416-(Vol.2).

The usefulness of a colloid propulsion system is compared to other propulsion systems. (M.O.W.)

13301 PLASMA ACCELERATION BY ELECTRON CYCLOTRON RESONANCE. Hutter, E. C.; Hendel, H.; Faith, T. (Radio Corp. of America, Princeton, N. J.). Contract AF-49(638)-1342. pp 105-21 of Advanced Propulsion Concepts. New York, Gordon and Breach, Science Publishers, Inc., 1966.

From 4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif. See CONF-650416-(Vol.2).

The basic physics of the acceleration process at power levels up to 500 W is discussed. A study of the engineering use of satellite station-keeping thrustors of this type indicates that the inherent long life of such devices makes them especially suitable for use in synchronous satellites. (M.O.W.)

13302 RECENT ADVANCES IN ELECTROTHERMAL AND HYBRID ELECTROTHERMAL-ELECTROMAGNETIC PROPULSION. John, Richard R.; Bennett, Stewart (Avco Corp., Wilmington, Mass.). Contracts NAS 3-2593; NAS 3-5908. pp 125-52 of Advanced Propulsion Concepts. New York, Gordon and Breach, Science Publishers, Inc., 1966.

From 4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif. See CONF-650416-(Vol.2).

The performance and practical application of electrothermal and electromagnetic space propulsion engines were investigated. The engines considered include the resistojet, the conventional (electrothermal) arc jet, and the hybrid (electrothermal–electromagnetic) arc jet. (M.O.W.)

13303 RECENT ADVANCES IN THE DEVELOPMENT OF ELECTROMAGNETIC PLASMA THRUSTORS FOR SPACE PROPULSION. Penfold, A. S. (Litton Systems, Inc., Beverly Hills, Calif.). pp 155-86 of Advanced Propulsion Concepts. New York, Gordon and Breach, Science Publishers, Inc., 1966.

From 4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif. See CONF-650416-(Vol.2).

Recent advances in the development of electromagnetic plasma thrustors are discussed with emphasis on those areas which are currently under intensive investigation. Experimental results and theoretical considerations regarding a rf fringe-field device of promising performance are presented for the first time. Then the theory and operation of low-density dc arcs are described, and the various mechanisms which operate to convey energy from the arc to the emerging plasma beam are discussed. It is shown that an average ion energy higher than the arc voltage can be obtained through the mechanism of collisions involving the Hall current, but that this process is inefficient. It is also shown that a specific impulse of 3000 seconds at reasonable efficiency cannot be obtained through the mechanism of self-field effects (blowing and pumping) at power levels below a few megawatts. The effect of mass recirculation on experimental determinations of specific impulse and efficiency is also considered. (auth)

13304 MHD GENERATORS FOR SPACE POWER. Kerrebrock, Jack L. (Massachusetts Inst. of Tech. [Cambridge]). pp 189-203 of Advanced Propulsion Concepts. New York, Gordon and Breach, Science Publishers, Inc., 1966.

From 4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif. See CONF-650416-(Vol.2).

The potential of MHD generators for space power is discussed. Critical problems and future areas of investigation are also discussed. (M.O.W.)

13305 AIR FORCE ADVANCED SOLAR TURBO ELECTRIC CONCEPT. Werbel, Jerome; Midyett, Charles L. pp 207-22 of Advanced Propulsion Concepts. New York, Gordon and Breach, Science Publishers, Inc., 1966.

From 4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif. See CONF-650416-(Vol.2).

The Air Force advanced solar turbo electric concept is described. Performance and design criteria include: 20 kW useful electrical output, 200 to 500 nautical mile orbit, 1 year design life, minimum development risk, minimum weight (1 lb/kW output), minimum packaging volume, maximum micro-meteorite protection, maximum system reliability, and minimum cost. (M.O.W.)

13306 PHOTOVOLTAIC POWER SYSTEMS. Goldsmith, John (Jet Propulsion Lab., Pasadena, Calif.); Menetrey, W. R.; Winsor, Keith L. pp 225-45 of Advanced Propulsion Concepts. New York, Gordon and Breach, Science Publishers, Inc., 1966.

From 4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif. See CONF-650416-(Vol.2).

A summary of the nature and features of photovoltaic arrays and associated power conditioning is presented. Several curves illustrate the potential usefulness of a lightweight solar power system, and how solar power can be mated with electric propulsion for primary propulsion, attitude control and station-keeping missions. The state-of-the-art in solar panels and other system components is described along with advanced concepts. The structural features of several types of multi-kilowatt solar arrays are discussed along with the problems associated with integrating the panels into a practical vehicle. Power conditioning and other components of high power solar systems, using electric propulsion and other loads, are described along with the anticipated problem areas in design and use. (auth)

13307 IMPROVEMENTS IN ELECTRIC GENERATORS. Peters, Martin Charles (to Babcock and Wilcox Ltd.). British Patent 1,096,861. Dec. 29, 1967. Filed Dec. 21, 1962.

The fluent medium used in the MHD generator described is formed of an elastic fluid and a dense suspension of finely divided, electrically conductive solid material. The medium may be CO_2 containing very finely divided graphite particles. It is contained in a closed circuit at a pressure of about 400 psi and serves also as the coolant of a nuclear reactor having a graphite-moderated core. A nuclear reactor core and the MHD generator may be enclosed within a common pressure vessel to form a power plant. (A.G.W.)

13308 VOL'T-AMPERNYE KHARAKTERISTIKI TERMOEMISSIONNYKH PREOBRAZOVATELEI. (Volt-Ampere Characteristics of Thermoemission Converters). Pyatnitskii, A. P.; Sergeev, D. I.; Nevezhin, O. A. Moscow, Atomizdat, 1967. 152p.

A systematic account is given of electrical measuring methods used in direct conversion of thermal energy (nuclear, solar, and chemical) into electrical. Brief descriptions are given of the principles for selecting suitable elementary diagrams, their calculations, and methods for experimental reading of the volt–ampere data. Original engineering methods for analyses and investigation of new dc current sources are discussed. Commutation of high current of low voltage and method for increasing the voltage are also discussed. 24 references. (R.V.J.)

Fluid Physics

13309 (67-C-102) EQUILIBRIUM SOLUTIONS OF MAGNETOHYDRODYNAMICS WITH AZIMUTHAL SYMMETRY. Miller, R. D. (General Electric Co., Schenectady, N. Y. Research and Development Center). Mar. 1967. 18p.

It is shown that all azimuthally symmetric equilibrium solutions of interest of the coupled differential equations of motion of magnetohydrodynamics for an inviscid, perfectly conducting fluid may be expressed in terms of the solutions of a single, second-order, scalar equation. This reduction occurs through the introduction of four arbitrary functions of the dependent variable. (auth)

13310 (ORNL-P-3297) HYDROMAGNETIC GOERTLER INSTABILITY IN A BOUNDARY LAYER ON A CONCAVE WALL. Chang, T. S.; Sartory, W. K. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 17p. (CONF-680201-2). Dep. CFSTI.

From 4th Southeastern Conference on Theoretical and Applied Mechanics, New Orleans, La.

The effect of an applied magnetic field on the Görtler instability of a Blasius boundary-layer flow over a concave wall is investigated analytically for the case where the fluid is a finite electrical conductor and the wall is perfectly conducting. The magnetic field, which is aligned parallel to the wall and perpendicular to the flow direction, is found to have a stabilizing effect just as with Taylor instability considered by earlier investigators. The effect on stability of the component of velocity normal to the wall in grow-

ing boundary layer is also considered by making calculations both with and without the normal flow terms. The normal flow is found to have a destabilizing effect, especially with small values of the Hartmann modulus. At large values of the Hartmann modulus, the normal flow appears to suppress the formation of oscillatory modes of instability. (auth)

13311 (NASA-TT-F-460) MOTION OF CONDUCTING BODIES IN A MAGNETIC FIELD. Liyelpeter, Ya. Ya. (ed.). Translation of Dvizheniye Provodyashchikh tel v Magnitnom Pole, Zinatne Press, Riga, 1966. 147p. CFSTI.

Articles are included on the theory of induction, magnetohydrodynamic (MHD) machines with a liquid-metal working medium, the electromagnetic processes in an ideal, conducting MHD machine, and the higher spatial harmonics of the magnetic field of an induction MHD machine. The transverse edge effect in plane, induction MHD machines, the longitudinal edge effect in linear MHD machines, the ponderomotive forces influencing conducting media in the traveling magnetic field of a cylindrical inductor, and a theory for the propagation of pulsed electromagnetic fields in moving, conductive media are discussed. (auth)

13312 VARIATIONAL PRINCIPLE FOR HYDROMAGNETIC FLOWS. Venkatarangan, S. N. (Indian Inst. of Tech., Madras). Bull. Cl. Sci., Acad. Roy. Belg., 53: 851-60(1967).

A variational principle is developed for hydromagnetic flows using the concept of local potential introduced by Glansdorff and Prigogine. As an example, the problem of flow of a viscous incompressible conducting fluid between two parallel plates with a transverse applied magnetic field is considered. A comparison between the exact and the approximate solutions is made. (auth)

13313 NORMAL VORTICITY AND CURRENT DENSITY GENERATED BEHIND A MAGNETOGASDYNAMIC SHOCK WAVE IN UNSTEADY FLOWS. Ram, Rishi (Univ. of Allahabad, India). J. Fluid Mech., 30: 805-8(Dec. 22, 1967).

Two interesting linear relations between normal vorticity and current density generated behind a shock wave in three-dimensional unsteady flows of conducting gases have been investigated in order to determine them purely from dynamical considerations. Some interesting physical conclusions have also been made. (auth)

13314 MEASUREMENTS OF DRAG IN A CONDUCTING FLUID WITH AN ALIGNED FIELD AND LARGE INTERACTION PARAMETER. Yonas, G. (California Inst. of Tech., Pasadena). J. Fluid Mech., 30: 813-21(Dec. 22, 1967).

The drag of spheres and disks has been measured in a flow of liquid sodium within an aligned magnetic field. A slightly viscous, strong field limit is discussed and explored experimentally. In this limit the drag coefficient was found to have an asymptotic dependence proportional to the square root of the interaction parameter, the ratio of magnetic to inertial force, independent of body shape. A physical model is presented along with preliminary verification of its basic characteristics. (auth)

13315 COMMENTS ON "CIRCULATORY FLOW OF A CONDUCTING LIQUID ABOUT A POROUS, ROTATING CYLINDER IN A RADIAL MAGNETIC FIELD". Chang, T. S.; Sartory, W. K. (Oak Ridge National Lab., Tenn.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 382-3(Feb. 1968).

A brief mathematical analysis is given. (M.O.W.)

13316 ELECTRODE VOLTAGE DROP IN A SEEDED PLASMA. Hara, Toshitsugu; Uchida, Motokazu (Hitachi Ltd., Tokyo). Jap. J. Appl. Phys., 7: 163-9(Feb. 1968).

The potential distribution in a duct has been measured in the presence of an externally applied voltage. The gas flowing through the duct has been a propane–oxygen combustion gas seeded with K_2CO_3 powder. The voltage–current characteristics have also been measured. The voltage drop is found to increase with the current density but to become independent of it above a critical current density. This critical current density and the voltage drop become smaller as the electrode temperature increases. It is concluded that the main causes of the voltage drop are the thin, cold gas layer near the electrode in the smaller current-density region, and the arc column in the region above the critical. Also, it is suggested that the electrode materials in the MHD generator should be selected on the basis of its capability of enduring as high temperature as possible rather than of its low work function. (auth)

13317 INFLUENCE OF CONVECTION ON CURRENT PATTERNS IN NONEQUILIBRIUM PLASMAS. Sherman, Arthur (General Electric Space Sciences Lab., Valley Forge, Pa.); Yeh, Hsuan. Phys. Fluids., 11: 96-106(Jan. 1968).

The phenomenon of convection is investigated in nonequilibrium plasmas where there are substantial nonuniformities in the plasma state. It is shown that a boundary-value problem can be formulated to solve for the current stream function and the electron temperature including convective effects. The resulting equations are coupled and nonlinear so they are solved by an iteration technique. Two simple examples are chosen to illustrate the procedure. The first consists of a pair of electrodes in a straight channel, and the second is the entrance region of a parallel-walled solid electrode device. In each case, only an applied electric field was considered. The calculations show the current streamlines and the electron temperature distribution displaced downstream for both uniform and nonuniform flows. It is also shown that as the flow velocity increases the voltage necessary to pass a specified amount of current increases. (auth)

13318 FORMULATION OF THE THEORY OF TURBULENCE. Orszag, Steven A. (Inst. for Advanced Study, Princeton, N. J.); Kruskal, Martin D. Phys. Fluids., 11: 43-59(Jan. 1968).

A theory of homogeneous, isotropic turbulence in an incompressible fluid is formulated. This theory provides a basis for the dynamics of fully developed turbulence. A hierarchy of equations to determine the time evolution of single-time moments of the velocity field is derived. Various properties of this hierarchy are exhibited, such as positivity of the dynamically determined energy density. The theory is applied to the study of the inertial range, where the Kolmogoroff theory is justified. A generalized inertial-range theory is formulated. This "semilocal" theory is characterized by local energy transfer and nonlocal relaxation of triple moments. The generalized theory is applied to the study of hydromagnetic turbulence, which is shown to possess a semilocal inertial range. (auth)

13319 MAGNETOHYDRODYNAMIC FLOW ALONG CYLINDRICAL PIPES UNDER NON-UNIFORM TRANSVERSE MAGNETIC FIELDS. Todd, L. (Univ. of Strathclyde, Glasgow). J. Fluid Mech., 31: 321-42(Jan. 29, 1968).

The unidirectional flow of an incompressible, electrically conducting, viscous fluid along cylindrical pipes is considered. An external magnetic field, B_0, which lies in the plane transverse to the flow is applied. It is shown that the governing equations, written in the co-ordinate system traced out by B_0, are mathematically very similar to those for a uniform field. Emphasis is on ducts whose walls are insulators. Though exact solutions (valid for all values of the Hartmann number) are derived, the limit of high Hartmann number is taken for detailed discussion. Transition layers (or, loosely, "wakes") can arise, which are centered on curved field lines. In somes cases, reversed flow occurs in part of the core ("radial-type" fields). Situations also arise where the magnitude (and sign) of the velocity remains the same as for $B_0 = 0$, whatever the strength of the applied, transverse (azimuthal) magnetic field. (auth) (UK)

13320 PLANE STEADY MAGNETOGASDYNAMIC FLOW: EXTENSION OF THE CROCCO–VAZSONYI FORMULA. Ferrero, Giorgio. Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur., 101: 901-15(1966-1967). (In Italian).

A study was made on a plane steady flow of a perfect, nonviscous, electrically conducting gas. For this the generalization to magnetogasdynamics of a Crocco–Vazsonyi formula was made and with it the motion of the gas was examined in reference to the case of circular streams, produced by a point-form vortex. (auth)

13321 COMPRESSIBLE LAMINAR MAGNETOHYDRODYNAMIC BOUNDARY LAYER FLOW WITH HEAT TRANSFER. Hwang, Un-pah. Manhattan, Kan., Kansas State Univ., 1967. 248p. Thesis.

The purpose of this study is to present an analysis of two-dimensional, steady-state, laminar, compressible flow of an electrical conducting fluid across a flat plate and inside a flat duct with a transversely applied magnetic field. The boundary layer equations for the compressible magnetohydrodynamic (MHD) flow are solved by an extension of Morris and Smith's approach to compressible non-MHD flow over a flat plate, which is based on the methods of Kármán–Pohlhausen and Dorodnitsyn. The compressible boundary layer equations including the continuity, momentum, and energy equations are reduced to ordinary differential equations which are solved simultaneously by numerical integration. The effects of compressibility, pressure, and surface temperature gradients on the characteristics of the boundary layer are solved simultaneously without imposing any restrictions on the Prandtl number. A very general form of viscosity variation with respect to temperature is used in the development of the general equations. (TSS) (Disser. Abstr.)

13322 FULLY DEVELOPED MAGNETOGASDYNAMIC FLOW BETWEEN DIVERGING PLANE WALLS. Maus, James Reginald

Jr. Raleigh, N. C., North Carolina State of the Univ. of North Carolina, 1967. 153p.

Thesis.

A solution has been obtained to the magnetogasdynamic equations of motion including the effects of compressibility viscosity, thermal conductivity and crossed electric and magnetic fields. The solution obtained is valid for an acceleration flow in which a separation of variable form of solution is utilized. The constraints under which a separable solution is valid are clearly delineated. The solution is an exact solution in the sense that no terms have been dropped from the governing equations and boundary layer approximations have not been employed. The results of the investigation were presented in the form of velocity and temperature profiles for several values of the electromagnetic parameters Ha and Φ. Although the mathematical model used in the present investigation is too crude to be utilized for detailed design of a practical MHD accelerator, it is believed, nevertheless, that the model displays certain qualitative features of the flow which are likely to be encountered in a practical device. (Disser. Abstr.)

Geophysics

Refer also to abstract 13243.

13323 IONOSPHERIC COMPOSITION AND REACTIONS. Donahue, T. M. (Univ. of Pittsburgh). Science, 159: 489-98 (Feb. 2, 1968).

Recent measurements of ion densities in the ionosphere seem to be more or less compatible with current data for ion–molecule reaction rates in some parts of the ionosphere under conditions in which a steady state prevails. There is no such agreement for the upper ionosphere, where the densities of He^+ and H^+ are difficult to understand in terms of present concepts concerning the relevant production and loss processes. Sources of ionizing radiation are needed to explain night-time observations in the E region and perhaps also in the F region. The D region remains a poorly understood laboratory of negative-ion and positive-ion chemistry, where neither observation nor theory is as yet adequate. (auth)

13324 TREND IN THE HARMONIC ENERGIES OF THE DIURNAL VARIATION AT TWO BRITISH OBSERVATORIES. Lamden, R. J. (United Kingdom Atomic Energy Authority, Brimpton, Eng.). Nature (London), 217: 347-9 (Jan. 27, 1968).

It is stated that earlier analyses of the world-wide distribution of the daily magnetic field variation may have been affected by subjective errors, as much of the work was done before the advent of high-speed computers. This communication presents the results obtained by a full Fourier analysis of a year's data from two British observatories, comparison of which allows errors in amplitude and phase of the spectral peaks to be estimated. The year 1964 was chosen as the most recent for which results are readily available. Both observatories were away from the coast, and hence should be free from tidally generated fields. Results are shown graphically. Good consistency was obtained, particularly for phase. (UK)

13325 EVOLUTIONARY PROCESSES AND REVERSALS OF THE EARTH'S MAGNETIC FIELD. Harrison, C. G. A. (Univ. of Miami, Fla.). Nature (London), 217: 46-7 (Jan. 6, 1968).

It has been suggested that there is a connection between reversals of the Earth's magnetic field and evolutionary processes, and the topic has excited much interest since the discovery of an apparent correlation between levels of field reversal and microfaunal discontinuities in deep sea sediment cores. During the reversal process there is a period of reduced or zero intensity of the dipole field, during which there should be an increase of cosmic radiation at the Earth, which is no longer shielded by its magnetic field. The enhanced radiation will produce a higher mutation rate, which may result in some kind of evolutionary discontinuity. Changes in intensity of the magnetic field will change only the radiation from cosmic rays and ^{14}C. It is estimated that the equatorial dose rate due to cosmic rays at present intensity should increase from 50 to 57 mRem/yr during a reversal, and that due to ^{14}C from 1 to 2.1 mRem/yr. If the Earth's dipole moment were larger than at present, there would have been a greater latitude effect. Studies of the palaeofield intensity indicate that the field has probably not been more than 1.5 times its present intensity for significant lengths of time, and that it was less intense during the Tertiary. The shielding effect of a larger field is calculated. Assuming the field strength was 1.5 times the present strength the equatorial dose rate during a reversal would change from 37 to 57 mRem due to cosmic rays and from 0 to 2.1 mRem/yr due to ^{14}C. Cosmic rays, however, produce only a small percentage of all observed mutations, and even in the case of a field 1.5 times the present intensity the change in mutation rate when the field goes to zero appears much too small to cause an evolutionary discontinuity. It is very unlikely that a reversal of the Earth's field could have a significant effect on the mutation rate of organisms at sea level, unless these organisms have a much lower spontaneous mutation rate than humans and other organisms studied. A possible cause of the apparent correlation between evolutionary discontinuities and reversals of magnetic polarity in deep sea cores might be a climatic change at the time of a reversal, and mechanisms for such changes are suggested. (UK)

13326 D-REGION ELECTRON DISTRIBUTIONS FROM FURTHER ROCKET MEASUREMENTS OF LF PROPAGATION. Hall, J. E.; Fooks, Jean (Radio and Space Research Station, Slough, Eng.). Planet. Space Sci., 15: 1717-22 (Nov. 1967).

The electron density in the D region of the ionosphere has been deduced from measurements of the amplitude of the wavefield above a ground transmitter operating at 202 kHz. New results from two daytime rocket flights, and corrected results from a previous flight, are presented. Although observations were spread over nearly a year, similar electron distributions were found for all three flights. A method of extending the distribution to E-region heights, using observations of the penetrating wave amplitude, is discussed. (auth) (UK)

13327 THE SPATIAL VARIATION OF AURORAL LUMINOSITY. II. DETERMINATION OF VOLUME EMISSION RATE PROFILES. Romick, G. J.; Belon, A. E. (Univ. of Alaska, College). Planet. Space Sci., 15: 1695-1716 (Nov. 1967).

The variation in the intensity of a stable isolated auroral arc was measured as a function of zenith angle from two stations located on the same geomagnetic meridian and separated by 226 km. The measurements were made with meridian scanning photometers which recorded simultaneously the emissions λ3914 (N_2^+), λ5577 [O I] and λ6300 [O I] at both stations. A comparison of the λ5577 and λ6300 data shows that excitation of the O [^{1}D] state by secondary electrons due to primary ionization processes cannot be the dominant process for the emission of λ6300, at least for altitudes above 250 km. Collisional deactivation of the excited O [^{1}D] atoms is essentially complete below 150 km and is important at least up to 240 km. A detailed analysis of the λ3914 (N_2^+) and λ5577 [O I] data in terms of volume emission rate profiles confirms the constancy of the ratio of λ5577 to λ3914 photon emission rates with height, which was inferred from single station measurements. The unexpected result of the present observations, however, is that the horizontal volume emission rate profiles are different for the two emissions, the λ5577 emission being concentrated toward the center of the λ3914 emitting region. It is concluded from these results that excitation of oxygen atoms by secondary electrons due to the primary ionization process cannot be the dominant process for the production of either the λ5577 or the λ6300 emission in the aurora. (auth) (UK)

13328 RADIATIVE ASSOCIATION: POSSIBLE IMPORTANT LOSS PROCESS FOR METALLIC IONS IN THE IONOSPHERE. Swider, W. (Air Force Cambridge Research Labs., Bedford, Mass.). Nature (London), 217: 438-9 (Feb. 3, 1968).

The maximum lifetime of a metallic ion, M^+, in the upper atmosphere is believed to be limited by radiative recombination, $M^+ + e \rightarrow M + h\nu$, which process is quickly followed by dissociative recombination. Radiative association is the rate limiting step in the neutralization of metallic ions, $M^+ \rightarrow MX^+ (MX_2^+) \rightarrow$ neutrals. The loss rate for metallic ions caused by radiative recombination is compared with the radiative association loss rates at altitudes of interest for the ions of Na, Ca, Mg, K, Si, Fe, Al, and Ni. Three-body processes involving $[O_2]^+$, [O] $[O_2]$, and N_2 are also considered. Since sporadic E may attain an electron density of 10^6 cm^{-3} radiative recombination may well be the dominant loss process leading to the neutralization of metallic ions near and above 110 km. Somewhere below 100 km the three body recombination process must become more important than radiative association. The reaction $X^+ + O_3 \rightarrow OX^+ + O$ cannot remove Fe and Mg ions since the dissociation energies of FeO^+ and MgO^+ appear to be less than for O_2 (5.1 eV), making such reactions endothermic. An exception may be $Si^+ + O_2 \rightarrow SiO^+ + O$, if the dissociation energy of SiO^+ is 5.66 eV. All metallic ion reactions with nitrogen are presumably endothermic. (UK)

13329 PREDICTING IONOSPHERIC ELECTRON DENSITY PROFILES. Haydon, George W. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.); Lucas, Donald L. Radio Sci., 3: 111-19 (Jan. 1968).

Typical measurements of the electron density in the various regions of the ionosphere are reviewed and the current availability of predictions based on these measurements is discussed. A method is suggested to combine regular ionospheric predictions such as f_0F2 and f_0E with estimates of electron density in the lower ionosphere and with empirical expressions for the electron

density in the upper ionosphere to obtain a first approximation to the electron density versus height profile for the quiet ionosphere. Sample profile predictions based on regular ionospheric predictions are shown for ionospheric heights of most importance in the design and operation of high-frequency communication systems. (auth)

13330 MAGNETO-ATMOSPHERIC WAVES IN A HORIZONTALLY STRATIFIED MEDIUM. Deutsch, R. V. (Polytechnic Inst., Iasi). Stud. Cercet. Fiz., 19: 807-21(1967). (In Rumanian).

Because of difficulties in the mathematical treatment, the propagation of perturbations in inhomogeneous media has been studied only in a few special cases, such as the propagation of weak perturbations in specific media, required for understanding the convective instability of a straight column, etc. In order to extend the validity of currently accepted concepts, the propagation of magnetohydrodynamic waves in compressible constrictive media, placed in a homogeneous gravitational field was investigated from the electrical point of view. The presence of the gravitational field results in the exponential decrease of the isothermic medium with the altitude. The two cases, required to ensure the horizontal stratification of the medium in static equilibrium—the homogeneous magnetic field being (a) horizontal with, or (b) perpendicular to the gravitational field—were examined in detail. For the parallel case, an approximation method was applied, to examine perturbations with a wavelength much shorter than the inhomogeneities of the medium; an exact solution was found for the differential equation corresponding to the Alfvén waves. For the perpendicular case, the propagation of the waves was examined with respect to media, in which the magnetic field intensity also decreases exponentially, resulting in a constant Alfvén velocity. The paper reviews earlier studies of K. Stepien and of the author on this subject. (TTT)

13331 MAGNETOSPHERIC PROPERTIES DEDUCED FROM OGO 1 OBSERVATIONS OF DUCTED AND NONDUCTED WHISTLERS. Smith, R. L.; Angerami, J. J. (Stanford Univ., Calif.). J. Geophys. Res., 73: 1-20(Jan. 1, 1968).

The OGO 1 satellite has yielded evidence for both ducted and nonducted modes of whistler propagation in the magnetosphere. Two new types of nonducted whistlers have been identified: the 'magnetospherically reflected' whistler and the 'Nu' whistler. These whistlers have never been observed on the ground. Their unique properties result in part from the presence of ions that permit reflection of whistler-mode energy in the magnetosphere. These phenomena provide a new tool for study of the distribution of ionization in the magnetosphere. Ducted whistlers from OGO 1 have provided the first in situ observations of whistler ducts. Near $L = 3$, the equatorial separations between ducts ranged from 50 to 500 km, and the equatorial thicknesses were about 400 km. The analysis yielded independent experimental support for the diffusive equilibrium model of distribution of ionization along the field lines in the plasmasphere. Some evidence was found of distortion of the magnetic field on the nightside at $L \sim 3$, possibly due to oblique incidence of the solar wind on the earth's field. (auth)

13332 PRELIMINARY RESULTS OF ELECTRIC FIELD MEASUREMENTS IN THE AURORAL ZONE. Foeppl, H.; Haerendel, G.; Haser, L.; Luest, R.; Melzner, F.; Meyer, B.; Neuss, H.; Rabben, H.-H.; Rieger, E.; Stoecker, J. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). J. Geophys. Res., 73: 21-6(Jan. 1, 1968).

In April 1967 five Nike–Apache rockets were launched from Kiruna, Sweden, carrying barium release and electron concentration experiments. The component of the electric field transverse to the magnetic lines of force is derived from the motion of the ion clouds. The electron concentration measurements provide is ionospheric conductivities. The magnitudes of the electric fields varied between 2 and 20 V/km. Their directions were northwestward for evening conditions and southwestward for morning conditions. The magnetic perturbations on the ground that would result from ionospheric currents derived on the basis of the measured fields and conductivities closely resemble the actual ground magnetometer data. The electric fields vary appreciably with space and time; they can even reverse their directions over distances of the order of 60 km. (auth)

13333 ION CHEMISTRY GOVERNING MESOSPHERIC ELECTRON CONCENTRATIONS. LeLevier, R. E. (Rand Corp., Santa Monica, Calif.); Branscomb, L. M. J. Geophys. Res., 73: 27-41(Jan. 1, 1968).

A theory and methodology for investigating the ion chemistry governing mesospheric electron concentrations is presented. In this theory, macroscopic reaction coefficients are defined in terms of the microscopic chemical reactions that take place between positive ions, electrons, and negative ions. The role of minor constituents of the atmosphere, O, O_3, CO_2, NO, and NO_2, is discussed using reaction rates measured in the laboratory. One reaction, the associative detachment of O_2^- by atomic oxygen is so fast that mechanisms for inhibiting or suppressing this reaction are required. The need for such mechanisms is dictated by field data on riometer absorption induced by the nuclear explosions of the 1962 Christmas Island air drops. The importance of terminating negative ions, i.e., negative ions that withstand the attack of atomic oxygen, is emphasized. Also emphasized is the influence of the ion–ion mutual neutralization coefficient of terminating negative ions. Four illustrative models of the ion chemistry are presented ranging from the simplest O_2^- model, which is certainly unrealistic, to a more complex model involving six species of negative ions. This model, which is suggested by recent measurements of reaction rates in the laboratory, does not include the effect of water vapor in the reaction scheme since little laboratory data exist on the reaction of negative ions with water. (auth)

13334 SATELLITE OBSERVATIONS OF INTERPLANETARY SHOCK WAVES. Gosling, J. T.; Asbridge, J. R.; Bame, S. J.; Hundhausen, A. J.; Strong, I. B. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Geophys. Res., 73: 43-50(Jan. 1, 1968). (LA-DC-8883).

Interplanetary shock waves propagating through the solar wind were observed with hemispherical plate electrostatic analyzers aboard the twin Vela 3 satellites. From the consideration of mass flux continuity, the shock velocities were calculated; the shock velocities determined from the data in this manner are consistent with the observed temperature changes across the shocks. These velocities are significantly less than the mean transit velocities of the shocks from the Sun to the Earth derived from the delay times between the initiating flares and shock arrival. This result is interpreted to mean that interplanetary shock waves are decelerated as they expand and propagate through the quiescent solar plasma. (auth)

13335 CORRELATED MAGNETIC FIELD AND PLASMA OBSERVATIONS OF THE EARTH'S BOW SHOCK. Greenstadt, E. W. (TRW Systems, Redondo Beach, Calif.); Green, I. M.; Inouye, G. T.; Hundhausen, A. J.; Bame, S. J.; Strong, I. B. J. Geophys. Res., 73: 51-60(Jan. 1, 1968).

Ion spectrums and magnetograms obtained simultaneously when the Vela 3A satellite crossed the Earth's bow shock were correlated. An intermediate form of ion spectrum, representing neither solar wind nor magnetosheath, but characterized by an irregular envelope and occasional large flux peaks, is found to correspond to the appearance of large-amplitude (10 to 25 γ), irregular magnetic oscillations of 4- to 30-sec period. The large spectral flux peaks of the shock seem to result from localized transient accelerations and decelerations of the bulk of the solar wind protons. Smaller-amplitude (<5 γ), longer-period (20 to 60 seconds), generally more regular magnetic oscillations are seen in the solar wind outside the shock where the direction of flow of ion flux peaks is found to oscillate in close correlation with magnetic waves. (auth)

13336 POWER SPECTRA AND DISCONTINUITIES OF THE INTERPLANETARY MAGNETIC FIELD: MARINER 4. Siscoe, G. L. (Massachusetts Inst. of Tech., Cambridge); Davis, L. Jr.; Coleman, P. J. Jr.; Smith, E. J.; Jones, D. E. J. Geophys. Res., 73: 61-82(Jan. 1, 1968).

Power spectra from 3×10^{-4} to 0.5 cps based on Mariner 4 interplanetary magnetic field data show a dependence on frequency f that is roughly of the form $f^{-\gamma}$ with γ typically near $3/2$ and essentially always between 1 and 2 for each of the three components and for the absolute value of the field. This is based on the analysis of data for days of widely ranging degrees of activity near solar minimum. Power levels were typically a factor of 10 higher for disturbed than for quiet days and, except on quiet days, were a factor of 2 higher for the various components than for the absolute value. Data relating to frequently occurring field discontinuities show few shocks and many contact surfaces. The associated current sheets are found to be unusually thin, roughly 50% of those analyzed had thicknesses less than 3500 km and 10% less than 500 km. The structure of the current sheets that produced the cleanest discontinuities was analyzed and shown to be consistent with that of a tangential discontinuity characterized by zero normal field and normal velocity components. The directional distribution of current sheet normals strongly suggests a local latitudinal solar wind shear that prevails over one sector and can change from sector to sector. The cross sections of magnetic filaments are found to be in some cases highly elliptical rather than more-or-less circular, again suggesting a latitudinal solar wind shear. (auth)

13337 CHARGED PARTICLE ENERGIZATION BY AN ARBITRARILY MOVING MAGNET. Birmingham, T. J.; Northrop, T. G. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 83-6(Jan. 1, 1968).

Second adiabatic theory is used to derive an asymptotic expression for the bounce-averaged rate of kinetic energy change $\langle \dot{W} \rangle$ experienced by charged particles trapped in electric and magnetic fields that conserve the first two invariants M and J of their motion. The restriction that there exists no electric field $E_{||}$, parallel to the magnetic field, reduces $\langle \dot{W} \rangle$ by one order in the adiabatic expansion parameter m/e from its $E_{||} \neq 0$ value. If in addition the magnetic field arises solely from, and convects rigidly with, the arbitrary motion of a perfectly conducting magnet, it is found that $\langle \dot{W} \rangle$ is smaller by yet another order in m/e. The results generalize and confirm the conclusions of Hones and Bergeson who consider $E_{||} = 0$ and the special case of a uniformly rotating conducting magnetized sphere with nonaligned rotation and magnetization axes. (auth)

13338 LOW-ENERGY SOLAR-COSMIC-RAY CUTOFFS: DIURNAL VARIATIONS AND PITCH-ANGLE DISTRIBUTIONS. Paulikas, G. A.; Blake, J. B.; Freden, S. C. (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res., 73: 87-95(Jan. 1, 1968).

Observation of solar protons in the 1 to 100-MeV interval during the solar proton event of September 2, 1966, shows that: (a) an important day–night asymmetry in the geomagnetic cutoffs exists, with the flux starting to decrease from the polar plateau value at higher invariant latitudes nearer the noon meridian than the midnight meridian; (b) the asymmetry is more pronounced for the lower-energy particles. Direct and indirect measurements of pitch-angle distributions show that a quasi-trapped flux of protons is established at high altitudes of the dayside of the polar cap. The nonisotropic pitch-angle distribution at invariant latitudes less than 75° near local noon is a manifestation of limited access of solar protons to some local times and is associated with the midday absorption recoveries observed with riometers. (auth)

13339 RADAR THOMSON SCATTER STUDIES OF PHOTOELECTRONS IN THE IONOSPHERE AND LANDAU DAMPING. Yngvesson, K. O. (Cornell Univ., Ithaca, N. Y.); Perkins, F. W. J. Geophys. Res., 73: 97-110(Jan. 1, 1968).

The velocity distribution of daytime ionospheric photoelectrons in the energy range 7 to 20 eV was investigated at altitudes near 600 km by measuring the intensity of radar Thomson scatter from the steady-state level of plasma waves in the ionospheric plasma. This intensity depends on the velocity distribution through plasma wave–particle interactions such as Landau damping. The measurements were carried out at the Arecibo Ionospheric Observatory ($L \approx 1.5$, geographic latitude 18°N). The experimental values for the vertically upward flux of photoelectrons are in the range $(3 \text{ to } 10) \times 10^9$ cm^{-2} sec^{-1}, and, for the upward energy flux, $(3 \text{ to } 13) \times 10^9$ eV cm^{-2} sec^{-1}. The experiments show that the daytime downward flux is equal to the upward flux to within experimental error (±50%) at Arecibo. Some December 1966 observations during the presunrise and postsunset periods have detected photoelectrons originating at the magnetic conjugate point. The effect of a weak ($\omega_p > \omega_c$) magnetic field on the Landau damping of plasma waves by a Maxwellian velocity distribution was investigated by changing the angle θ between the radar beam and the magnetic field. The theoretical prediction that the Landau damping is orders of magnitude larger than the field-free case and depends strongly on angle was verified experimentally. (auth)

13340 VERTICAL MOVEMENT OF TEMPERATE-ZONE SPORADIC E LAYERS. Chimonas, G.; Axford, W. I. (Cornell-Sydney Univ. Astronomy Center, Ithaca, N. Y.). J. Geophys. Res., 73: 111-17(Jan. 1, 1968).

The wind-shear theory of the formation of temperature-zone sporadic E layers is extended to take into account effects associated with a neutral wind profile having a descending phase velocity. It is shown that layers of long-lived ions (presumably of meteoritic origin) that are formed at higher altitudes are carried down with the wind profile to a region roughly 85 to 95 km in altitude, where they are dumped. Above about 95-km altitude the layers are trapped in portions of the neutral wind profile having a shear of the correct sign according to the simple (equilibrium) form of the wind-shear theory. Below about 95 km the layers are not trapped in this manner, and their position shows no obvious correlation with the sign of the neutral wind shear. The effects of diffusion are discussed, and an expression for the equilibrium width of a sporadic E layer is obtained. (auth)

13341 SPECTRAL INTENSITY RATIOS IN PROTON-INDUCED AURORAS. Eather, R. H. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 119-25(Jan. 1, 1968).

The ratios of the intensity of λ3914 N_2^+, λ4709 N_2^+, λ5577 O I, and λ6300 O I to the Hβ intensity were measured in proton-excited auroras. The ranges in measured ratios (described by one standard deviation from the mean) are 10.0 to 17.5, 0.9 to 1.3, 9.0 to 12.5, and 2.5 to 3.3, respectively, and these are in reasonable agreement with theoretical predictions. Recommended values to use for these ratios are 17.0, 1.0, 10.0, and 3.0, respectively. The results may be used to estimate the relative importance of proton and electron excitation in auroras. (auth)

13342 ABNORMALLY LARGE ELECTRON CONCENTRATION IN THE IONOSPHERIC F2 REGION SUMMER-NIGHT IN MIDDLE LATITUDES. Sato, Teruo (Japan Defence Agency, Tokyo). J. Geophys. Res., 73: 127-42(Jan. 1, 1968).

Abnormal foF2 diurnal variations in summer with low noon and high midnight values, occurring most predominantly around Yakutsk in the Asian zone and Port Lockroy in the Antarctic, are analyzed, and the cause is investigated. The anomaly is thought to be due to the enhancement of electron concentration at summer-night. Under the assumption that this enhancement of electron concentration is caused by the horizontal movement of electrons due to electromagnetic and gravitational forces, the continuity equation in a nonsteady state for a two-dimensional (horizontal) F2 region model is solved numerically. Calculated electron concentration variations with time in the area concerned agree approximately with the observed ones. On this basis, the reason for the occurrence of the anomalous foF2 diurnal variation in restricted areas is inferred. Effectiveness of the two-dimensional treatment is also discussed. (auth)

13343 OBSERVATIONS OF PROTONS IN THE MAGNETOSPHERE AND MAGNETOTAIL WITH EXPLORER 33. Armstrong, T. P.; Krimigis, S. M. (Univ. of Iowa, Iowa City). J. Geophys. Res., 73: 143-52(Jan. 1, 1968).

Protons in the magnetosphere and magnetotail were observed with a silicon detector on Explorer 33. Detectable fluxes of protons $E_p > 0.31$ MeV were measured to 10.4 R_E on the sunward side of the Earth and, for the first time with the present experiment, to 80 R_E in the magnetotail. The small proton fluxes ($\lesssim 5$/cm^2 sec ster) measured in the magnetotail were usually anisotropic, with the largest flux apparently flowing down the tail, away from the Earth. When proton burst occurred in the tail, there was usually increased high-latitude magnetic bay activity at the Earth. Durably trapped proton fluxes were observed to have intensities and spectra in agreement with previous measurements. A diurnal variation (in the L coordinate system) was observed in the 0.31- to 10-MeV trapped protons for $L > 6.6$ R_E. (auth)

13344 ACCELERATION OF TRAPPED PARTICLES DURING A MAGNETIC STORM ON APRIL 18, 1965. Brown, W. L. (Bell Telephone Labs., Murray Hill, N. J.); Cahill, L. J.; Davis, L. R.; McIlwain, C. E.; Roberts, C. S. J. Geophys. Res., 73: 153-61(Jan. 1, 1968).

A polar substorm-particle event is described which was observed with the magnetic field and trapped particle detectors on Explorer 26 during the worldwide magnetic storm of April 17–18, 1965. The event occurred between 0600 and 0830 UT on April 18 within the main phase of the magnetic storm. During this time the satellite was near apogee ($L \simeq 5$) and at a local time of ~1300 hours. Nearly coincident with the polar substorm, the satellite records show that the local magnetic field decreased by about 40 γ, while the proton flux (100 to 345 keV) increased by more than a factor of 10. About twenty minutes later the electron flux (10 to 1000 keV) started to increase. Both the field and particles show large fluctuations that are inversely correlated. Some of the possible explanations of the event and the limitations imposed by the observations are discussed. (auth)

13345 MOTION OF CHARGED PARTICLES IN A SPIRAL FIELD. Winge, C. Richard Jr.; Coleman, Paul J. Jr. (Univ. of California, Los Angeles). J. Geophys. Res., 73: 165-73(Jan. 1, 1968).

Following a brief discussion of Parker's spiral-field model, the behavior of charged particles in this idealized interplanetary magnetic field is investigated. Defining equations are given for pertinent variables, and their values are plotted or tabulated as functions of heliocentric range for various values of the model parameters, proton energy, and pitch angle. The variables include the radius of curvature, arc length, gradients of the lines of force, particle drift and velocity, and flight time of protons. A modified magnetic moment that depends upon the drift velocity, and the energy limits for adiabatic motion that require that the magnetic moment remain invariant are determined for particles in this ideal field. (auth)

13346 PARTICLES INCIDENT ON MAGNETIC FIELD GRADIENTS. Stevenson, T. E.; Comstock, C. (Pennsylvania State Univ., University Park). J. Geophys. Res., 73: 175-84 (Jan. 1, 1968).

A study of the motion of single particles incident on a model magnetic field with a substantial gradient at an angle to the boundary has suggested that the results are relevant to particle penetration through the magnetospheric boundary. (auth)

13347 A REVISED (B,L) COORDINATE SYSTEM TO ALLOW FOR DISTENTION OF THE MAGNETOSPHERE BY A SYMMETRIC RING CURRENT. Kavanagh, Lawrence D. Jr. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 185-98(Jan. 1, 1968).

The McIlwain (B,L) coordinate system for describing physical points within the magnetosphere is modified to take account of magnetospheric distortions arising from symmetric ring currents, their associated induction fields, and a constant magnetopause boundary field on the day side of the earth. The goal in making such a modification is to develop a general procedure whereby stormtime magnetospheric distortions may be separated out of satellite particle data, making it possible to observe some of the more subtle aspects of particle behavior that otherwise may be hidden by larger effects. To demonstrate the usefulness of the modified (B,L) system, some new cases of Explorer 12 particle detector data are presented in which the particle configuration appears to be undergoing radial diffusion when plotted in the standard (B,L) system. However, when the counting rates are replotted in the modified system that accounts for ring currents, the diffusion is no longer evident. These cases are thus at least partially explained as being the effect of gross motion of the field lines themselves, rather than particle motion through the field lines. (auth)

13348 ELECTRON OMNIDIRECTIONAL INTENSITY CONTOURS IN THE EARTH'S OUTER RADIATION ZONE AT THE MAGNETIC EQUATOR. Owens, H. D.; Frank, L. A. (Univ. of Iowa, Iowa City). J. Geophys. Res., 73: 199-208(Jan. 1, 1968).

A comprehensive graphic display of the omnidirectional intensities of electrons (E > 40 keV, >230 keV, and >1.6 MeV) in the outer radiation zone observed during the ten-month period October 1962 through July 1963 with an array of Geiger–Mueller tubes borne on Explorer 14 is presented. The observations are displayed as contours of constant omnidirectional intensities of electrons with energies exceeding the above thresholds as functions of shell-parameter L and time at the magnetic equator. Although many of the phenomena apparent in these maps of outer-zone electron intensities have previously been discussed, the present graphic summary provides an extensive panorama of the morphology of the energetic electron distributions in the outer zone and a compact, concise medium for comparison with related ground-based and satellite measurements of geophysical phenomena. (auth)

13349 MAGNETIC MERGING IN THE MAGNETOSPHERIC TAIL. Dessler, A. J. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 209-14(Jan. 1, 1968).

It is proposed that magnetic merging across the neutral sheet of the geomagnetic tail takes place very near the Earth (i.e., between about 10 and 30 R_E). The plasma density in the near-Earth portion of the tail is usually low because the supersonic solar wind leaves a rarefied wake region extending about 30 R_E behind the dipole-like magnetosphere. The merging of oppositely directed field lines occurs when the plasma density is too low to form a current sheet of sufficient strength to prevent merging. (This mechanism is self-limiting in that the plasma energy density is built up by the merging processes to be almost, but not quite, the required level.) The magnetic merging then takes place somewhat as it would in a vacuum. Merging in the neutral sheet, then, depends on the development of vacuum-like conditions immediately behind the earth. This vacuum-merging mechanism preserves the essential features of frozen-in flux that have been so successful in predicting the configuration of both the spiral interplanetary magnetic field and the extended magnetospheric tail. Magnetic merging does not appear to proceed when the plasma density is high enough to produce the currents required to prevent merging. (auth)

13350 ON THE PHYSICAL SIGNIFICANCE OF THE Es PARAMETERS fbEs, fEs, AND foEs. Reddy, C. A. (National Center for Atmospheric Research, Boulder, Colo.); Rao, M. Mukunda. J. Geophys. Res., 73: 215-24(Jan. 1, 1968).

The simultaneous observations of midlatitude sporadic E by rockets and ionosondes are analyzed to compare the rocket-observed maximum plasma frequency in Es with the corresponding ionogram values of fbEs, fEs, and foEs. The results of the analysis show that (i) the blanketing frequency (fbEs) gives the maximum electron concentrations in the Es layers within an error of about 10% on the average, and (ii) both fEs and foEs give electron concentration values exceeding the rocket-observed maximum electron concentrations by 40 to 100% during daytime and by several hundred per cent during nighttime. The deduction of foEs from the observed fEs and the identification of foEs with the ordinary ray "critical frequency" of Es are shown to be questionable. (auth)

13351 DEDUCING THE MAGNITUDES OF IONOSPHERIC IRREGULARITIES FROM BACKSCATTER MEASUREMENTS. Weinstock, Jerome (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Geophys. Res., 73: 225-31 (Jan. 1, 1968).

A method is proposed for estimating the absolute magnitudes (amplitudes) of irregularities in ionospheric electron concentration from the backscatter of radiation at a single wavelength. This method is valid when the exploring radiation wavelength is much less than the characteristic lengths of the irregularity. There is also a geometrical condition that requires that a certain part of the surface of the scattering volume lie within the irregularity. As an example, an equatorial E-region irregularity is estimated to be about a 3% perturbation of the mean background density. This is preceded by a rigorous formalism for relating the magnitudes of such irregularities to radiation-scattering cross sections. The formalism is based on an extension of the usual homogeneous theory of scattering to include macroscopic inhomogeneities of the density. The homogeneous theory, it is argued, is not relevant to the magnitude of irregularities. The overall limitations of scattering as a technique for determining irregularity magnitudes are discussed. (auth)

13352 PERIODIC DISTURBANCES IN THE IONOSPHERE. Titheridge, J. E. (Univ. of Auckland, New Zealand). J. Geophys. Res., 73: 243-52(Jan. 1, 1968).

Total electron content measurements, at latitudes of 34°S and 42°S, showed that 30 to 50% of all large-scale irregularities in the ionosphere are periodic in space and in time. The observed wavelengths were generally between 40 and 160 km. The periods ranged from about 60 minutes down to a sharply defined lower limit of 15 minutes. This agrees precisely with the spectrum for gravity waves in the F region. Periodic disturbances did not occur near sunrise and sunset. Daytime disturbances caused periodic changes in total content of a few per cent, and were present for about 5% of the time at the lower latitude in summer. They became more common at the higher latitude and in winter, when the ionosphere was continually disturbed by the passage of large irregularities. Most of these had periods of about 20 minutes, suggesting a thermobaric resonance in the F region. Nighttime disturbances were generally more intense and occurred most frequently at the lower latitude in summer. (auth)

13353 DIURNAL VARIATION OF THE ELECTRON CONCENTRATION IN THE LOWER MAGNETOSPHERE AS DETECTED BY LUNAR RADAR EXPERIMENT. Yoh, Philip (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 73: 253-8(Jan. 1, 1968).

During the period from December 1963 to April 1964, a large number of simultaneous measurements of the Faraday polarization rotation and the differential Doppler frequency of lunar radar echoes were made at Stanford, California. The results showed a large temporal variation of the electron content above the Earth's ionosphere. This variation of electron content is attributed to an exchange of ionization between the ionosphere and the lower magnetosphere (protonosphere). A net upward electron flux of about 3.7×10^{12} m^{-2} sec^{-1} is found in the morning; the corresponding number of downward flow in the afternoon is about 2.8×10^{12} m^{-2} sec^{-1}. If a diffusive-equilibrium model is assumed, it can be demonstrated that the cause of the flow is the change of temperature in the region of the upper ionosphere and the lower magnetosphere. (auth)

13354 SOLAR CYCLE EFFECTS ON GEOMAGNETIC Pi 2 PULSATIONS. Saito, Takao; Matsushita, S. (National Center for Atmospheric Research, Boulder, Colo.). J. Geophys. Res., 73: 267-86(Jan. 1, 1968).

Rapid-run magnetograms of more than 6000 Pi 2 events generally associated with bay disturbances observed at Onagawa, Japan, and Fredericksburg, Virginia, during the years from 1956 through 1966 were analyzed to search for solar cycle effects. Yearly occurrence frequency of the Pi 2's including not only large amplitudes but also medium and small ones showed an inverse relation with solar activity. The local time of the maximum occurrence of Pi 2 changed from year to year between 22 h and

01 h LT. The daily occurrence frequency of Pi 2 seemed to have a systematic recurrence tendency caused by the solar rotation. The Pi 2 period decreased from 1957 to 1960 and increased from 1962 to 1965, depending on the magnitude of the accompanying bay disturbance. In relation to these solar cycle variations of Pi 2, an occurrence mechanism of magnetic field oscillations at the time of Pi 2 events is discussed based on the data at 14 world-distributed stations. (auth)

13355 INVESTIGATION OF POSSIBLE IONOSPHERIC HEATING BY HYDROMAGNETIC WAVES. Sorenson, William R. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 287-94 (Jan. 1, 1968).

Satellite drag analyses have shown that the temperature of the upper atmosphere of the earth increases during a magnetic storm. It has been suggested that hydromagnetic (hm) waves present in the ionosphere during a magnetic storm may dissipate enough energy to produce the observed heating. The hm wave spectrum in the ionosphere during four magnetic storms was determined by relating the magnetic fluctuation spectrum measured at the earth's surface by a rubidium vapor magnetometer to the hm wave spectrum in its ionosphere. An upper limit on the power input into the ionosphere by hm waves with frequencies less than 10 cps was determined and found to be insignificant compared with the flux of extreme ultraviolet solar radiation. These results show that for midlatitude, hm waves with frequencies less than about 10 cps produce no significant ionospheric heating. (auth)

13356 THE MORPHOLOGY OF SPREAD-F OCCURRENCE OVER HALF A SUNSPOT CYCLE. Singleton, D. G. (Weapons Research Establishment, Salisbury, Australia). J. Geophys. Res., 73: 295-308(Jan. 1, 1968).

An analysis has been made of bottomside spread-F data obtained at sunspot minimum at stations separated in latitude but grouped about 80° west longitude. At this part of the solar cycle, the temporal variations of the occurrence of the frequency-spreading component of spread F change with geomagnetic latitude in a manner comparable to that at sunspot maximum, the main differences being the following. The low-latitude region of high occurrence expands to higher latitudes as the sunspot number decreases. The high-latitude region of high occurrence is not so strong in sunspot minimum as in sunspot maximum. A third region of high occurrence about 10° latitude wide centered on 50° geomagnetic latitude, which is not so obvious at sunspot maximum, appears at sunspot minimum. This midlatitude region of occurrence on the bottomside is identified with the topside spread F attributed to the ducting process. A comparison of the high- and low-latitude regions of high bottomside frequency-spreading occurrence with their topside counterparts results in the conclusion that, at these latitudes, the occurrence properties of topside ducting are not substantially different from those of topside scattering. (auth)

13357 DISTRIBUTIONS AND LIFETIMES OF N AND NO BETWEEN 100 AND 280 KILOMETERS. Ghosh, S. N. (Univ. of Michigan, Ann Arbor). J. Geophys. Res., 73: 309-18(Jan. 1, 1968).

The distribution of N atoms between the altitude range 100 and 280 km was computed from reactions between constituent particles of the atmosphere and assuming their rate coefficients at laboratory temperature (300°K) to be constant for the whole altitude range. It was also calculated for rate coefficients varying with temperature. It was found that the latter distribution, which is considerably different from the former, gives a reasonably good profile. Since, in many cases, reactions involving loss of N atoms lead to the production of NO molecules, the altitude distribution of NO molecules was also calculated. The computed N and NO distributions compare favorably with certain rocket experiments and laboratory data. From the loss processes, the lifetimes of N and NO were computed. (auth)

13358 COORDINATED MEASUREMENTS OF AURORAL ABSORPTION AND LUMINOSITY USING THE NARROW BEAM TECHNIQUE. Berkey, F. T. (Univ. of Alaska, College). J. Geophys. Res., 73: 319-37(Jan. 1, 1968).

The correlation of ionospheric absorption with aurora was examined using photometers and riometers with narrow (~7°) beamwidths. The observations are discussed in terms of three broad categories: Category A describes the occurrence of bright aurora and strong auroral absorption; category B illustrates the occurrence of bright aurora accompanied by negligible absorption; and category C events were those of dim aurora and strong absorption. During the auroral substorm, category A events occur at the midnight meridian, while category B and C events occur in the evening and morning sectors, respectively. Category C events occur coincident with eastward drifting patches and pulsating aurora. The ratio of absorption to the square root of λ5577 intensity $[db/(kR)^{\frac{1}{2}}]$ was derived and used to make inferences concerning the energy spectrum of auroral electrons. The ratio gradually increased between 2300 and 0600 hours local time, implying a gradual hardening of the energy spectrum during this time. Observations of the auroral Hβ emission line showed that proton precipitation correlated poorly with ionospheric absorption. The riometer antenna beam was switched alternately between 6° north and 6° south positions. The absorption recorded in the two directions was highly correlated. The correlation between auroral luminosity in the corresponding directions was less well correlated. It was concluded that the absorbing region was, at times, larger than the region containing the luminous aurora. (auth)

13359 PROPAGATION OF ELF AND VLF WAVES BELOW AN ANISOTROPIC IONOSPHERE WITH A DIPPING STATIC MAGNETIC FIELD. Galejs, Janis (Sylvania Electronic Systems, Waltham, Mass.). J. Geophys. Res., 73: 339-52(Jan. 1, 1968).

Fields of cylindrically curved ionosphere layers are approximated by exponential functions that consider the increase of the phase velocity and decrease of the attenuation rate with the altitude of the layers. Matrix multiplication techniques are applied to the treatment of multilayer ionosphere models. The individual ionosphere layers are thin relative to the wavelength, and the approximate field representations give in the limits of horizontal and radial static magnetic field results identical to those obtained using more accurate treatments of curvature effects. TM modes in the space between the Earth and the ionosphere excite coupled TM and TE modes in the ionospheric layers, the presence of which are considered in an iterative solution of the modal equation. In the elf range, propagation parameters computed for the east-to-west (EW) and west-to-east (WE) directions differ most for dip angles of 15 to 30°. In the vlf range propagation parameters may exhibit discontinuities at nighttime for the EW direction, when the fields penetrate higher into the ionosphere. The interference distance D of the two lower wave guide modes is increased for propagation in the EW direction relative to propagation in WE direction provided that the electron concentration profiles exhibit sharp density gradients at heights in the range from 80 to 85 km. The desired propagation characteristics could not be produced in the presence of a nondipping static magnetic field or using smoothly varying electron concentration profiles. (auth)

13360 EFFECT OF ATMOSPHERIC WIND STRUCTURE ON SHORTER-PERIOD, NUCLEAR-GENERATED INFRASOUND. Meecham, William C. (Univ. of California, Los Angeles. Rand Corp., Santa Monica, Calif.). J. Geophys. Res., 73: 377-84 (Jan. 1, 1968).

One of the outstanding characteristics of acoustic signals received from nuclear explosions is their great time duration. This is true for long-period waves (greater than 1 minute), for intermediate-period waves (about 1 minute), and for short-period waves (less than 1 minute). Furthermore the extended signal often contains a very great number of (apparent) pulses of 10 to 20-sec duration. Ordinary dispersion cannot account fully for either the duration-effect or the multipulse appearance. It is suggested that for intermediate periods the extended signal duration may be due to horizontal refraction from large-scale weather fronts. The change in travel time due to this horizontal refraction can account for the signal duration. It appears that the multipulse short period behavior may be a diffraction effect. It is shown that the very commonly occurring wind ducts, with wind speeds of 3 m/sec and several thousand feet thickness, can "split" the pulse hundreds of times by diffracting the pulse. Such splitting into a transmitted and a reflected portion occurs for component time periods of 10 to 20 sec. This splitting and the attendant delay may account for some of the shorter-period signal characteristics. (auth)

13361 ACCURACY OF SATELLITE DOPPLER DATA FOR IONOSPHERIC STUDY, NAVIGATION, AND GEODESY. Willman, J. F. (Southwest Research Inst., San Antonio); Tucker, A. J. J. Geophys. Res., 73: 385-92(Jan. 1, 1968).

The accuracy of satellite Doppler data for navigation, geodesy, and ionospheric electron content determination has been suspect because of failure to eliminate the effects of transmission path inequality caused by refraction. Previous examination of ionospheric refraction has revealed a frequency dependence allowing the required correction when three frequencies are received simultaneously. A ray-tracing program on a digital computer is used to simulate satellite passes, and the resultant errors in a two-frequency and three-frequency data are presented and compared. The three-frequency Doppler technique is shown to effectively reduce residual ionospheric refraction errors to negligible amounts for the conditions considered. (auth)

13362 VLF AMPLITUDE PERTURBATIONS IN THE ANTARCTIC DUE TO THE NUCLEAR EXPLOSION OF JULY 9, 1962. Carpenter, G. B. (Stanford Research Inst., Menlo Park, Calif.); Kupferman, R. A.; Coroniti, S. C.; Gassmann, G. J. J. Geophys. Res., 73: 393-403(Jan. 1, 1968).

Broadband vlf magnetic tape recordings were obtained at Byrd, South Pole, and Cape Hallet in the Antarctic and onboard the U.S.N.S. "Eltanin" near Valparaiso, Chile, during the Starfish high-altitude nuclear event of July 9, 1962. Amplitudes of selected vlf transmitter signals are presented, confirming the existence of disturbed ionospheric conditions over a wide geographical area. Comparison of signal perturbations on various pairs of paths from common transmitters provides evidence of disturbed conditions at L values greater than 6. (auth)

13363 DEVELOPMENT OF A RADIO SIGNAL FROM A NUCLEAR EXPLOSION IN THE ATMOSPHERE. Gilinsky, Victor; Peebles, Glenn (Rand Corp., Santa Monica, Calif.). J. Geophys. Res., 73: 405-14(Jan. 1, 1968).

The dipole radio signal from a low-altitude atmospheric nuclear explosion of low yield is computed by numerically integrating Maxwell's equations. The source is described by a simple model. The function describing the time history of the rate of gamma output is taken to be an isosceles triangle with a base equal to a fraction of a microsecond. The asymmetry necessary for radiation comes entirely from the variation of air density with altitude. The dipole fields are shown as functions of position for various times after the explosion. These curves form, in effect, a motion picture of the development of the signal. (auth)

13364 ASYMPTOTIC SOLUTIONS OF WAVES IN INHOMOGENEOUS PLASMA WITH LONGITUDINAL MAGNETIC FIELD. Rao, S. S.; Unz, H. (Univ. of Kansas, Lawrence). J. Geophys. Res., 73: 415-20(Jan. 1, 1968).

The asymptotic solutions to the second-order differential equations governing the wave propagation in inhomogeneous plasma are given where the external magnetic field is assumed to be in the longitudinal direction. The zero-, first-, second-, third-, fourth-, and fifth-order approximations are explicitly given. It is further shown that the third-order asymptotic approximation agrees with the WKBJ approximation. Numerical results for a linear profile of electron concentration are given, and they are found to improve the WKBJ approximation. (auth)

13365 THE AIRGLOW SPECTRUM, 3100 TO 10,000 A. Broadfoot, A. Lyle; Kendall, Kenneth R. (Kitt Peak National Observatory, Tucson, Ariz.). J. Geophys. Res., 73: 426-8 (Jan. 1, 1968).

The present atlas has two major advantages: (1) the intensity scale is strictly linear; and (2) the whole region accessible from the ground by photoelectric techniques is shown to a uniform, absolute scale. A scanning spectrometer was used to obtain the spectrum. The instrument was an Ebert–Fastie type with a 1-m focal length. It had a 102 × 135-mm grating with 1200 lines/mm and blazed at 7500 Å. (W.D.M.)

13366 SIMULTANEOUS IMP 2 AND OGO 1 OBSERVATIONS OF BOW SHOCK COMPRESSION. Binsack, Joseph H.; Vasyliunas, Vytenis M. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 73: 429-33(Jan. 1, 1968).

Simultaneous observations from the plasma probes on IMP 2 and OGO I were used to investigate quantitatively the question whether large-scale motions of the bow shock that occur during magnetic storms result primarily from the over-all compression of the entire magnetosphere–magnetosheath system by the enhanced solar wind dynamic pressure. Specifically, it was possible (1) to verify that this shock motion occurs nearly simultaneously on the dawn and dusk sides of the magnetosheath and (2) to use one satellite to monitor the solar-wind pressure while the other was observing the shock. (W.D.M.)

13367 COMPARISON OF THE ELECTRON RESPONSE IN THE MAGNETOSPHERE AT L = 5 WITH THE SOLAR WIND DURING THE APRIL 17–18, 1965, MAGNETIC STORM. Lanzerotti, L. J. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Geophys. Res., 73: 438-41(Jan. 1, 1968).

Recently published data by Gosling et al. (1967) show the temporal changes in the solar wind parameters during the large magnetic storm of April 17–18, 1965. Since the mechanism for the coupling of the solar wind energy to the particle population in the interior of the magnetosphere is of interest, it is believed that a qualitative comparison of the temporal behavior of the solar wind with the outer-belt electron response of the magnetosphere during this magnetic storm period is of value. (W.D.M.)

13368 ENERGY FLUXES OF LOW-ENERGY PROTONS AND POSITIVE IONS IN THE EARTH'S INNER RADIATION ZONE. Frank, L. A.; Swisher, R. L. (Univ. of Iowa, Iowa City). J. Geophys. Res., 73: 442-4(Jan. 1, 1968).

A large energy flux, exceeding 50 ergs/cm^2 sec ster, of low-energy protons or ions within the energy range ~0.5 keV to 1 MeV at low altitudes in the inner radiation zone was reported by Freeman (1962) via analysis of the responses of CdS crystals borne on Injun 1. Toward obtaining a more comprehensive study of these large energy fluxes of positive ions an initial survey was conducted of measurements of the differential energy spectra of positive ions (100 eV ≤ E/Q ≤ 50 keV) in the inner radiation zone with an array of sensitive electrostatic analyzers borne on OGO 3. (W.D.M.)

13369 WAVES IN THE IONOSPHERE PRODUCED BY NUCLEAR EXPLOSIONS. Baker, Donald M.; Davies, Kenneth (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Geophys. Res., 73: 448-51(Jan. 1, 1968).

Some observations are presented on the propagation, at ionospheric heights, of waves with periods of about 1 min generated by nuclear explosions. The observations were made at Boulder using a high-frequency Doppler technique. This technique monitors changes of ionization by recording variations in the frequency of radio waves reflected from the F2 layer at heights between about 150 and 200 km. The type of event consists of a train of rhythmical oscillations. (W.D.M.)

13370 CALCULATIONS OF THE INTERACTION OF THE SOLAR PLASMA WITH THE MAGNETIC FIELD OF A CURRENT LOOP AND TWO PARALLEL INFINITE LINES OF CURRENT. McKinzie, Daniel J. Jr.; Julius, Anthony L. Jr. (Lewis Research Center, Cleveland). J. Spacecraft Rockets, 5: 3-8(Jan. 1968).

The forces resulting from the interaction of the unconfined magnetic field emanating from a space vehicle with the undisturbed solar plasma (solar wind) are investigated. The integrated theoretical drag per unit area and the acceleration of a circular current loop exposed to the solar wind at zero incidence are determined. The calculations are based on the theoretical results of a paper by J. R. Spreiter and B. R. Briggs. For the current loop, the drag per unit area varied from approximately 7.2×10^{-7} to 3.35×10^{-4} N/m^2 over a range of proton number densities from 10^6 to 10^8 particles/m^3 and a magnetic-field induction parameter from 10^{-4} to 10^{-2}T. The particle fluxes from a major solar flare have a negligible effect on the drag when compared with that from the solar wind. For a hypothetical superconducting coil (hollow torus) having a permanent unconfined magnetic field, the maximum acceleration calculated is approximately 1.37×10^{-4} m/sec^2. Also, the integrated theoretical drag and lift per unit area and restoring moment per unit area per unit length of span are calculated for the case of two parallel infinite lines of current at a 45° angle of incidence; the lift per unit area is approximately $\frac{1}{7}$ of the drag per unit area. (auth)

13371 COSMIC-RAY EFFECTS AND FAUNAL EXTINCTIONS AT GEOMAGNETIC FIELD REVERSALS. Black, D. I. (Cambridge Univ., Eng.). Earth Planet. Sci. Lett., 3: 225-36(Dec. 1967).

Studies of deep-sea cores show that the last reversal of the earth's magnetic field and the extinction of a group of Radiolarian species occurred simultaneously: the evidence suggests a possible causal relation. Some effects on the earth and atmosphere at a field reversal are quantitatively considered, but it is shown that no direct or indirect radiation effect from cosmic rays or solar flares, nor any solar wind effect, can be a significant factor in the extinction of the species. The grounds for believing in a causal relation between magnetic and faunal changes are examined. (auth)

13372 LOCAL TIME ASYMMETRIES IN THE HIGH-LATITUDE BOUNDARY OF THE OUTER RADIATION ZONE FOR THE DIFFERENT ELECTRON ENERGIES. McDiarmid, I. B.; Burrows, J. R. (National Research Council, Ottawa). Can J. Phys., 46: 49-57(Jan. 1968). (NRC-9834).

Data obtained from the Alouette II satellite were used to examine various high-latitude boundaries of the outer radiation zone as a function of local magnetic time. Four different boundaries were defined and these are referred to as the 35-keV "background" boundary, the 35-keV "smooth" boundary, the 35-keV "sharp" boundary, and the 3.9-MeV "background" boundary. All of the boundaries showed a marked dependence on local magnetic time. The 35-keV "smooth" and the 3.9-MeV "background" boundaries were identified with the stable trapping region and showed a 1100- to 2300-hr asymmetry of about 3°. The 35-keV "background" boundary falls at higher latitudes than the other boundaries at all

local times; a noon–midnight asymmetry of about 6° was observed as well as a marked dawn–dusk asymmetry. The 35-keV "background" boundary was tentatively associated with the boundary of closed geomagnetic field lines and it is suggested that there is a dawn–dusk asymmetry in the field configuration. The 35-keV "sharp" boundary was identified with the inner edge of the "cusp" region and its relation to the other boundaries was examined. (auth) (Canada)

13373 APPARENT POLEWARD MOTION OF ONSETS OF AURORAL ABSORPTION EVENTS. Jelly, Doris H. (Defence Research Telecommunications Establishment, Ottawa). Can. J. Phys., 46: 33-7(Jan. 1968).

A study was made of nighttime auroral radio absorption events observed by riometers in the latitude range of $\lambda = 67$ to 76°. Individual events were shown to extend over this range with a tendency to occur later at higher latitudes. If the observed onset delay time is interpreted as a poleward expansion of the disturbance, the corresponding average velocity is 0.8 km/s. This velocity is consistent with the poleward motion observed during visual auroral substorms. The absorption events were compared statistically with energetic electron events detected by the Alouette I satellite. (auth) (Canada)

13374 UNIVERSITY OF BIRMINGHAM ELECTRON DENSITY AND TEMPERATURE EXPERIMENTS ON THE ARIEL III SATELLITE. Wager, J. H. (Univ. of Birmingham, Eng.). Radio Electron. Eng., 35: 55-63(Jan. 1968).

An experiment to measure ionospheric electron densities based upon the detection of permittivity changes in a parallel plate capacitor is discussed briefly, together with a method of determining electron temperatures based on the comparison of differential currents to identical probes. The application of these techniques to the Ariel III satellite and some preliminary results are also described. (auth) (UK)

13375 ARIEL III SATELLITE PROJECT. Campbell, F. P.; Ladd, A. C. (British Aircraft Corp., Stevenage, Eng.). Radio Electron. Eng., 35: 17-32(Jan. 1968).

Ariel III carries equipment from five scientific groups in the U.K. to measure ionospheric and high atmosphere properties. The project management structure is described. The spacecraft configuration evolved from two fundamental requirements–spin stabilization and power supply by solar cells. The evolution of the structure and subsystems, together with the operation of various mechanisms, is outlined. The reliability, needed and achieved, of electronic ground equipment is stressed, and operations at the Western Test Range, California are discussed. The choice of orbit was a compromise between several experimental requirements and the capability of the Scout launch vehicle. Data acquisiton and processing are discussed. (auth) (UK)

13376 VECTOR MEASUREMENT OF THE MID-LATITUDE Sq IONOSPHERIC CURRENT SYSTEM. Cloutier, Paul Andrew. Houston, Tex., Rice Univ., 1967. 138p.
Thesis.

The results of two rocket-borne vector magnetometer experiments are presented and evaluated. These experiments were designed to detect and measure the vector direction of the magnetic field associated with an ionospheric current system. This current system is responsible for the solar quiet daily magnetic variation of the geomagnetic field, Sq. The location and magnitude of the current layer have been previously determined by rocket-borne scalar magnetometers flown by other investigators, but direct vector measurements of the current system have not been previously made. The vector experiments were conducted in November, 1965 and February, 1966 at Wallops Island, Virginia. Single-cell cesium vapor magnetometers with vector magnetic biasing coils were carried by Nike–Apache sounding rockets to near 170 km altitude. The observational and theoretical history of the Sq variation is presented, and the present state of theoretical development is discussed in some detail. Particular emphasis is given to the problem of ionospheric tensor conductivities, including analysis of the height profiles of the conductivity components and the relation between electric field direction and current direction. The experimental techniques are discussed, and the flight instrumentation is described. The vector analysis necessary for the determination of the magnetic field vector components in the vehicle-oriented coordinate system and for translation of the vector to a ground-based coordinate system (by means of vehicle aspect information) is performed. Current layers were detected on both flights, as indicated by discontinuities in the altitude profiles of the geomagnetic field magnitude. Vector information obtained on the second flight showed the current direction to be mainly westward, in agreement with the direction expected from the ground magnetic measurements. The vector measurements also indicated a highly disordered magnetic field within the current layer. The current structures measured on these flights were thin, intense current layers between 100 and 110 km altitude. Using electron density altitude profiles obtained by ground ionosondes, the tensor conductivity components are evaluated. These calculations indicate that the position and intensity of the current layer were controlled by an enhancement of the electron density in sporadic E layers observed during flight. It is shown that variations in enhancement may be responsible for the variety of current structures reported by this and other investigators. It is shown that all experimental and theoretical results appear to be compatible within the known range of ionospheric variability, although incomplete information on ionospheric conditions prevents a critical test of theory. (Disser. Abstr.)

13377 WORLDWIDE DISTRIBUTION OF TIDES IN THE IONOSPHERE. Rush, Charles Merle. Los Angeles, Univ. of California, 1967. 129p.
Thesis.

Records of hourly values of ionospheric parameters such as the critical frequencies of the F2 and sporadic-E layers and their respective heights are subjected to spectral analysis. It is found that the spectrum of the critical frequency of the F2 layer in the frequency range 0 to 4 cycles per day consists of well identified 'lines' which originate as a result of the tidal action of the Sun and the Moon. The most important of these lines represent oscillations with solar diurnal, solar semi-diurnal, and lunar semi-diurnal periods. Mutual relationships of these tidal oscillations are studied as functions of solar epoch, geographical location, and season of the year by cross-spectral methods and by the method of harmonic analysis due to Chapman and Miller. The tidal effects are geomagnetically controlled, with the amplitudes and phases reaching maxima on either side of the geomagnetic equator. In the case of the lunar semi-diurnal tide, the observed variation near the equatorial regions is the effect of the latitude variation of the height of the F2 maximum. In fact, at these latitudes, study of the luni–solar effect shows that this tide exhibits a height variation almost independent of solar activity. The spectrum of the critical frequency of the sporadic-E layer is similar to the spectrum of the critical frequency of the F2 layer. The main tidal lines are common to both spectra. Certain interesting phase relationships between the two spectra are studied and discussed. As a preliminary step in the understanding of the interrelationships between tidal effects in the ionosphere and in the geomagnetic elements, results of tidal analyses of geomagnetic data from 40 observatories throughout the world are given. In addition, the ionospheric and geomagnetic spectra are compared by cross-spectral analysis. (Disser. Abstr.)

13378 ANNALS OF THE IQSY (INTERNATIONAL YEARS OF THE QUIET SUN). VOLUME I. GEOPHYSICAL MEASUREMENTS: TECHNIQUES, OBSERVATIONAL SCHEDULES, AND TREATMENT OF DATA. Minnis, C. M. (ed.). Cambridge, Mass., Massachusetts Institute of Technology Press, 1968. 415p. $20.00.

Instructural material is given on the recording of solar radio emissions, the reporting of sudden ionospheric disturbances, auroral observations, methods and standards for the measurement of airglow, the recording of cosmic rays, and the observation of comet movements. (W.D.M.)

13379 SELF-CONSISTENT CALCULATION OF THE EARTH'S RADIATION BELTS. Baker, John Cummins. Davis, Calif., Univ. of California, 1967. 40p.
Thesis.

Self-consistent calculations were made of the pressure, current, and magnetic fields from a two-dimensional model of the earth's radiation belts. Answers are also attempted for the following four questions: (1) is self-confinement possible; (2) how much plasma can the earth's field support if self-confinement is not possible; (3) does the plasma magnetic field aid or oppose the earth's magnetic field at the equator; and (4) is it possible for the magnetic field to reverse direction inside the radiation belt. (Disser. Abstr.)

Low-Temperature Physics

Refer also to abstracts 12631, 12632, 12695, 12702, and 14100.

13380 (CEA-Bib-101) MOBILITE DES ELECTRONS ET DES IONS DANS L'HELIUM LIQUIDE. MISE AU POINT BIBLIOGRAPHIQUE. (Mobility of Electrons and Ions in Liquid Helium. Survey of Current Literature). Schwob, Jean-Louis (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1967. 34p. (In French). Dep.
Thesis.

Recent experiments on charged-particle mobility in liquid helium ^{4}He confirm the quantum theory of superfluidity at very low temperatures. Results obtained in small electric fields are interpreted in terms of ion scattering by elementary excitations: rotons (between 2 and 0.6°K) and phonons (below 0.6°K), while ion motion in strong fields is explained by the creation of quantized vortex rings. The results also show the existence of a complex structure of ions in liquid helium. The different models proposed in the literature are discussed. A large number of recent experimental data seems to be satisfactorily explained by the "electrostriction model" for positive ions, in which an atom cluster is formed around He_2^+, and by the "bubble model" for negative ions which are assumed to be constituted of an electron trapped in a cavity. 45 references. (auth)

13381 (CEA-R-3172) CRYOSTAT HORIZONTAL POUR CIBLES DE PROTONS POLARISES. (Horizontal Cryostat for Polarized Proton Targets). Roubeau, Pierre M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 136p. (In French). Dep.

Thesis. Submitted to Univ. of Grenoble, Faculte des Sciences, France.

A continuously fed horizontal cryostat to be used for polarized proton targets includes: a standard storage Dewar commercially available; shifting of the Dewar requiring 10 minutes, without any warming of the target; no conventional nitrogen-cooled shield but use of the cold helium vapors evaporated in the transfer line and/or the helium evaporated to cool the polarized crystal; a heat exchanger which reduces by a factor of two the consumption of helium; regulation of the temperature by means of a needle valve included in the superfluid helium line. This cryostat, used in conjunction with a 1000 liters/sec pump allows one to maintain at 1.06°K a target, in which is dissipated 1 watt hyperfrequency power, with a helium consumption of 40 liters/day (measured directly in the storage Dewar). (auth)

13382 (NP-17258) MANY-BODY PROBLEMS. VOLUME II. Lectures Given at the Niels Bohr Institute and NORDITA, Copenhagen. Brown, G. E. (Nordisk Institut for Teoretisk Atomfysik, Copenhagen (Denmark)). 1967. 198p. Dep.

Four lectures are included on the following: (1) random phase approximation, (2) Landau theory of Fermi liquids, (3) phonons and electrons, and (4) theory of superfluidity. (M.O.W.)

13383 (NYO-3699-20) A MODEL CALCULATION OF THE LIQUID STRUCTURE FACTOR OF LIQUID ^{4}He. Kerr, William Clayton (Cornell Univ., Ithaca, N. Y.). Sept. 1967. Contract AT(30-1)-3699. 127p. Dep. CFSTI.

Thesis.

A method is devised for calculating liquid structure factors of liquid ^{4}He using interpolation techniques on the theory of gases and solids. (M.O.W.)

13384 CRYOSTAT FOR THE MEASUREMENT OF THERMAL CONDUCTIVITY AND SPECIFIC HEAT BETWEEN 0.05 AND 2°K. Harrison, J. P. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-2391. Rev. Sci. Instrum., 39: 145-52(Feb. 1968). (NYO-2391-52).

A cryostat is described which is capable of measuring specific heat and thermal conductivity of dielectric crystals over the temperature range 0.05 and 2.0°K. Thermal conductivity is measured with a steady flow of heat through the sample, and specific heat by a pulse technique. Differential carbon resistance thermometry is used for both measurements. The performance is demonstrated on the thermal conductivity of LiF, and on the specific heat of two samples of nominally pure KCl. (auth)

13385 SUPERCONDUCTIVITY AND ANTIFERROMAGNETISM IN BORON-RICH LATTICES. Matthias, B. T.; Geballe, T. H.; Andres, K.; Corenzwit, E.; Hull, G. W.; Maita, J. P. (Bell Telephone Labs., Murray Hill, N. J.). Science, 159: 530(Feb. 2, 1968).

Ferromagnetism, antiferromagnetism, or superconductivity has been discovered in most hexa- and dodecaborides. (auth)

13386 SUPERCONDUCTING BRIDGE RECTIFIER AND REMARKS ON CURRENT SUPPLY FOR SUPERCONDUCTING COILS. Fasel, R.; Olsen, J. L. (Eidgenossische Technische Hochschule, Zurich). Kaeltetech.-Klim., 19: 274-8(Sept. 1967). (In German).

Superconducting solenoids in an external magnetic field can be used as rectifier elements. A bridge circuit using such elements is described and its properties as current supply for superconducting magnetic field coils are investigated. The losses in the rectifier are compared with those caused by ordinary leads into the cryostat. (auth)

13387 INTERACTION OF AN INDIVIDUAL PARTICLE WITH PHONONS IN AN INTERACTING MANY-BOSON SYSTEM. Nishiyama, Toshiyuki (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 38: 1062-82(Nov. 1967).

The behavior of an individual particle interacting with phonons in a many-boson system is investigated in the scheme of the collective description by using the number density operator and the phase operator as the collective variables. For a model-interaction potential which is strong but of long-range, it is shown that the third order anharmonic terms to appear in this collective description give rise to the backflow effect of the individual particle which has been discarded in the random phase approximation. The Feynman-Cohen wave function and the dipole-type interaction between individual particles transmitted by phonons are obtained. In relation to Puff's theory of sum rules the spectral function associated with the density-density correlation function for individual particles is also investigated. (auth)

13388 INTRODUCTION TO MANY-BODY FORMALISM. Neidhardt, W. Jim (Newark Coll. of Engineering, N. J.). Amer. J. Phys., 35: 853-6(Sept. 1967).

An elementary approach is presented to the many-body formalism needed to understand simple models of superfluid systems. In the framework of occupation number, space-particle conserving operators that represent single-body and two-body observables are constructed in an intuitive manner. It is then shown that this formalism when applied to such observables as single-particle energy and two-body interaction potential yields results which are physically plausible. The basic formalism for the understanding of many-body systems is thereby presented without recourse to a complete development of quantum field theory. (auth)

13389 IDEAL FLUX-FLOW RESISTANCE IN A TYPE-II SUPERCONDUCTING ALLOY. Cape, J. A.; Silvera, I. F. (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Rev. Lett., 20: 326-9(Feb. 5, 1968).

Experiments are reported that establish linear V vs I and current-independent R vs H behavior and it was found that this ideal resistivity is in excellent agreement with predictions of the large microscopic theory, over a large variation of the dc current. (M.O.W.)

13390 ABSORPTION OF LONGITUDINAL LONG-WAVE ULTRASOUND IN SUPERCONDUCTING ALLOYS HAVING A MULTIBAND ANISOTROPIC FERMI SURFACE. Fal'ko, I. I. (Kharkov State Univ., USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 1668-9(Jan. 1968).

Translated from Fiz. Tverd. Tela, 9: 2124-6(July 1967).

An expression for the experimentally measured relative absorption coefficient of longitudinal ultrasound in superconducting alloys in the multiband anisotropic model was derived by a correlation-function method. From this expression it follows that for a multiband superconductor the amount of absorption will be different in different directions with respect to the crystallographic axes. (A.G.W.)

13391 NUCLEAR SPIN-LATTICE RELAXATION IN PURE AND IMPURE SUPERCONDUCTING INDIUM. Butterworth, J.; MacLaughlin, D. E. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Rev. Lett., 20: 265-7(Feb. 5, 1968).

Nuclear spin-lattice relaxation measurements in the superconducting state of pure indium and of indium-lead solid solutions show behavior consistent with an essentially impurity-independent broadening of the superconducting energy gap. This conflicts with previous ideas on the importance of energy-gap anisotropy. (auth)

13392 SURFACE NUCLEATION FIELD H_{c3} OF PURE LEAD. Fischer, Gaston (RCA Labs. Ltd., Zurich). Phys. Rev. Lett., 20: 268-71(Feb. 5, 1968).

New measurements of $H_{c3}(T)$ are presented for pure Pb. The analysis of the present data suggests that $H_{c3}(T)$ in pure Pb depends strongly upon the type of electron scattering at the surface. When this effect is properly taken into consideration, it is possible to derive the bulk critical field $H_{c2}(T)$ and Ginzburg-Landau parameter $\kappa_1(T)$ of pure Pb, with results very close to predictions from recent theories of strong-coupling superconductors. (auth)

13393 COHERENCE EFFECTS IN DOUBLE LAYERS OF DIFFERENT SUPERCONDUCTORS. Bergmann, G.; Hilsch, R. (Univ., Goettingen, Ger.). Kurznachr. Akad. Wiss. Goettingen, 2: 57-60(1966). (In German).

The transition temperatures of double layers using Hg, Sn, In, Tl, Al, Zn, Cd, and Cu as lower layers of between 1000 and 1830 Å thickness were determined as a function of the thickness of the Pb layer between 0 and 800 Å thickness. A detailed comparison between theory and experiment was made with In-Pb where the In was condensed at 20°K to thicknesses between 280 and 3100 Å and Pb at 4.2°K to thicknesses between 0 and 700 Å. Very close

agreement between theory and experiment obtained throughout the determinations confirmed the theory and indicated that intermediate layers and diffusion can be eliminated in such experiments. (BBB)

13394 MODEL TREATMENT OF A DILUTE ^{3}He SOLUTION IN LIQUID ^{4}He. Nagata, Tsuneo; Soda, Toshio; Sawada, Katsuro (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 38: 1023-30 (Sept. 1967).

Elementary excitations of the synthesized system of a dilute ^{3}He solution in liquid ^{4}He are calculated. The model Hamiltonian is used, which expresses the energies of the fermion and boson systems as the collection of energies of the boson-type elementary excitations like phonon, roton, zero sound and pair excitations. The stability of the synthesized system is discussed by finding the nonimaginary value of the energy. The condition for a phase separation is derived. As an application the thermal conductivity of the ^{3}He–^{4}He system is computed for very low temperatures, approximating the synthesized excitation as composed of phonon and particle-hole excitations. The conductivity is expressed in terms of the phonon part and the ^{3}He part, with modifications due to the ^{3}He concentration. (auth)

13395 TOPOLOGICAL PECULIARITIES OF ELECTRON SPECTRA IN SUPERCONDUCTING METALS. Bar'yakhtar, V. G.; Lazarev, B. G.; Makarov, V. I. (Kharkov State Univ. Kharkov Inst. of Physics and Tech.). Fiz. Metal. Metalloved., 24: 829-42(Nov. 1967). (In Russian).

Experimental research carried out in the Khar'kov Inst. of Physics and Technology is reviewed. A new method was developed for producing high pressures at low temperatures, and the influence of the high pressure on T_c and H_c was determined. Superconductor data showed both $dT_c/dp < 0$ and $dT_c/dp > 0$. The thallium peculiarity of nonlinearity of T_c with pressure and the theory of T_c linear variations with pressure are discussed. A method involving combined effects of impurities and pressure was developed to study fine variations in the Fermi-surface topology, from which electron transitions in thallium and indium were revealed. (tr-auth)

13396 CRITIQUE OF THE SAUNDERS THEORY OF SOLID ^{3}He AT 0°K. Mullin, W. J. (Univ. of Minnesota, Minneapolis). Contract AT(11-1)-1569. Phys. Rev., 166: 142-51(Feb. 5, 1968). (COO-1569-16).

An examination is made of the theory of the ground state of solid ^{3}He proposed by Saunders (EMS) and modified by Garwin and Landesman (GL). We find the theory is inconsistent or wrong in the following respects: Unphysical single-particle functions result from a misapplication of the Pluvinage method of generating a wave function; the heuristic derivation of an expression for the exchange integral J is inconsistent with this wave function; a correct solution for the integral equation for the single-particle probability density has not been given; the heuristic expression used for the cohesive energy is inconsistent with the Pluvinage method. The use of the Pluvinage method and the single-particle probability density in the theory are analyzed in detail. The numerical results given in EMS and GL, such as for the exchange integral, are shown to be in doubt because of the errors. We discuss a possible modification of the method, which is not subject to these criticisms, and which gives results similar to those of Nosanow's cluster-expansion theory. (auth)

13397 PRESSURE DEPENDENCES OF THE TRANSPORT COEFFICIENTS OF LIQUID ^{3}He AND THE SPIN-FLUCTUATION THEORY. Betts, David S. (Univ. of Sussex, Eng.).; Rice, Michael J. Phys. Rev., 166: 159-66(Feb. 5, 1968).

The observed pressure dependences of the low-temperature spin diffusion D, thermal conductivity K, and shear viscosity η of liquid ^{3}He are interpreted in this paper on the basis of Rice's recent spin-fluctuation theory. With regard to this theory, some new theoretical expressions are obtained: With the use of a more realistic model for the spin-fluctuation weight function, improved calculations are obtained for the limiting low-temperature values α_K, α_D, and α_η, respectively, of the quantities $1/KT$, $1/DT^2$, $1/\eta T^2$. The effects of longitudinal spin fluctuations, neglected previously, are also included. Within the bound of experimental error, the phenomenological pressure dependence predicted by theory is in good qualitative agreement with experiment. Moreover, considerably improved quantitative agreement is furnished by the improved calculations of α_K, α_D, and α_η. (auth)

13398 SUPERFLUID DENSITY OF He II IN THE CRITICAL REGION. Tyson, J. A. (Univ. of Chicago). Phys. Rev., 166: 166-76(Feb. 5, 1968).

The superfluid density of liquid ^{4}He near the λ point has been measured using the oscillating-disk-pile technique. From accurate measurements of the period of oscillation as a function of the temperature difference T_λ-T, the superfluid density ρ_s is found to obey the power-law expression $\rho_s = 1.43\rho(T_\lambda - T)^\zeta$ with $\zeta = 0.666 \pm 0.006$. This power-law dependence closely resembles that found in other systems near a symmetry-breaking higher-order phase transition. In particular, Josephson has shown for He(II) that the value $\zeta = \frac{2}{3}$ is a direct consequence of a logarithmically divergent specific heat ($\sim\ln|T_\lambda - T|$). Thermodynamic and scaling arguments suggest that the coherence length in He(II) varies as $(T_\lambda - T)^{-\zeta}$. Our result for the superfluid critical exponent ζ, together with the superfluid-specific-heat data of Kellers, Fairbank, and Buckingham, are consistent with the validity of the Widom–Kadanoff–Josephson scaling laws. (auth)

13399 OBSERVATION OF QUANTIZED CIRCULATION IN SUPERFLUID HELIUM. Whitmore, S. C.; Zimmermann, W. Jr. (Univ. of Minnesota, Minneapolis). Phys. Rev., 166: 181-96 (Feb. 5, 1968). (COO-1569-13).

An experimental study has been made of the circulation of the superfluid component of liquid helium II around a fine wire. The method used was that of Vinen, in which the circulation is measured by means of the influence it has on the transverse vibrations of the wire. The present work extends Vinen's original work in several ways. Measurements were made over a range of temperatures from 1.2 to 1.9°K and a range of wire diameters from 25 to 100 μ. In addition, measurements of the direction of the apparent circulation were made as well as of the magnitude. The experiments have two principal results. The first is that motion of the superfluid around the wire could persist for many hours after any motion of the containing vessel had stopped. However, this motion was not steady; smooth changes in apparent circulation could take place throughout an experimental run, changes which could include reversals in direction. The second principal result is that the apparent circulation tended to show markedly greater stability at the anticipated quantum levels than at other values. Long periods of stability were observed at the levels of 0, 1, 2, and 3 quantum units. An additional significant result is that as the wire diameter was increased the maximum value of metastable circulation observed also increased. (auth)

13400 THERMOELECTRIC EFFECT IN SUPERCONDUCTORS. Kresin, V. Z.; Litovchenko, V. A. Zh. Eksp. Teor. Fiz., 53: 2154-8(Dec. 1967). (In Russian).

The thermoelectric effect in superconductors is investigated on basis of the microscopic theory of superconductivity. A thermoelectric current arises in an anisotropic superconductor under the action of a temperature gradient. The thermoelectric coefficients are calculated. It is shown that for $T \to T_c$ the magnetic field of the thermoelectric current is quite sufficient for experimental observation. (auth)

13401 RADIATION LINE WIDTH IN THE JOSEPHSON EFFECT. Larkin, A. I.; Ovchinnikov, Yu. N. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz., 53: 2159-63 (Dec. 1967). (In Russian).

It is shown that the line width of radiation in the Josephson effect is determined by voltage fluctuations at the contact. The line width as a function of the contact parameters and characteristics of the external circuit is found. (auth)

13402 SUPERCONDUCTING LEAD LAYERS WITH ADDITION OF TRANSITION METALS AND THEIR OXIDES. Hilsch, R.; Wassermann, E. (Univ., Goettingen, Ger.). Kurznachr. Akad. Wiss. Goettingen, 2: 63-4(1966). (In German).

The rapid cooling method for preparing thin layers of superconductors is used to prepare Pb films containing Cr, Mn, Fe, Co, and Gd. The transition temperature decreases linearly with increasing concentration: for the added atoms as listed above, $-dT_c/dc$ is found to be 620, 2100, 470, 80, and 200. These values indicate the number of host atoms with which an added atom must be mixed to lower the transition temperature of the Pb by 1°K. The effect of transition metal oxides was also studied: $-dT_c/dc$ is 4500 for Cr_2O_3, 2600 for MnO, and 80 for Co oxides, taking only the metal concentration. The fate of the oxide is not known, but deposits of oxides on glowing W ribbons were not conducting. The deposition rate of the additive also plays a sensitive role in the superconductivity of the host; intermediate stages of alloys are obtained. (BBB)

13403 PRODUCTION AND DETECTION OF VERY HIGH FREQUENCY RESONANCE THROUGH QUANTUM PROCESSES IN SUPERCONDUCTORS. Eisenmenger, Wolfgang (Univ., Goettingen, Ger.). Kurznachr. Akad. Wiss. Goettingen, 2: 115-20(1966). (In German).

A cylindrical single crystal of sapphire with superconducting tunnel contacts (Sn, SnO_2, Sn) evaporated on polished faces was maintained at 1.3°K. One contact served as phonon sender, and

the other as receiver. A 0.3-μsec impulse was placed on the sender with a constant voltage; the receiving contact was maintained at 0.8 mV, so that the rest tunnel current is determined by the density of thermally excited quasi particles. Impulse increase briefly modified the tunnel stream. Longitudinal and transverse wave signals were observed, as well as another possibly due to diffuse reflection from the cylinder wall. The amplitude of the transverse signal depends on the value of the voltage on the sender side. Signals at the receiver arise from phonons of energy $\geq 2\Delta$. Another process involved invokes energy transfer from the injected quasi particles on application of voltage at the sender through transitions up to the upper band edge and then through recombination of quasi particles to Cooper pairs. (BBB)

13404 ON ANTIFERROMAGNETIC SPIN ORDERING OF PARAMAGNETIC ADDITIVES IN SUPERCONDUCTORS IN THE CASE OF CHILLING CONDENSED LAYERS. Hilsch, R.; Korn, D. (Univ., Goettingen, Ger.). Kurznachr. Akad. Wiss. Goettingen, 2: 61-2(1966). (In German).

A typical plot of reciprocal susceptibility vs temperature for a cooling condensed layer (Cu–5 at. % Mn) is described. A linear plot that can be extrapolated through the origin is obtained, so that no paramagnetic Curie temperature is found. An antiferromagnetic spin ordering sets in at 20°K; this value is found to be a linear function of Mn concentration in Mn–Pb. Compact samples possess a generally positive Curie temperature. The different behavior is suggested to be related to the different distribution of the added atoms in the two cases. A compact sample has deviations from statistical distribution in lattice points, while the rapidly condensed samples have added atoms deposited randomly. Compact La–10% Gd samples have a Curie temperature of 4°K and a spin-ordering temperature of 4.5°K, while the evaporated sample has a zero Curie temperature, and the spin-ordering temperature is shifted only slightly to lower values. (BBB)

13405 ON THE SPIN BRANCH OF COLLECTIVE EXCITATIONS OF THE SUPERCONDUCTING FERMI LIQUID WITH S-PAIRING. Czerwonko, J. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 667-71(1967).

The Larkin–Migdal theory of the superconducting Fermi liquid was used to calculate energies for spin branch of collective excitations with a gap in the long wavelength limit. (M.O.W.)

13406 UTILIZATION OF NUCLEAR MAGNETIC RESONANCE FOR INVESTIGATION OF THE PECULIARITIES OF THE THERMODYNAMIC PROPERTIES OF ^{3}He–^{4}He SOLUTIONS AT λ-TRANSITION. Grigor'ev, V. N.; Esel'son, B. N.; Masimov, E. A.; Mikhailov, G. A.; Novikov, P. S. (Physico-Technical Inst. of Low Temperatures, Kharkov). Ukr. Fiz. Zh., 12: 1786-94(Nov. 1967). (In Russian).

A method of the direct measurement of ^{3}He distribution between liquid and vapor in helium isotopic solutions based upon the utilization of nuclear magnetic resonance is developed. The installation for nuclear magnetic resonance measurements in ^{3}He–^{4}He solutions at low temperatures is described. The ^{3}He distribution between liquid and vapor phases for 15.0% and 31.8% ^{3}He solutions within the temperature range of 1.45 to 2.1°K is studied. The peculiarities, associated with theoretically predicted ones of the distribution factor, were detected at temperature dependences of amplitude signal ratios on vapor and liquid phases at temperatures corresponding to λ transition. (auth)

13407 CALCULATION OF A HYSTERESIS LOSS IN A TYPE-II SUPERCONDUCTOR. Kaiho, Katsuyuki; Ihara, Seijiro; Hidaka, Kazuhiko Denki Shikensho Iho, 31: 1004-14(Sept. 1967). (In Japanese).

By using the magnetization curve equation of a type-II superconductor reported by Yasukochi, the hysteresis loss of a flat strip superconductor was calculated. The loss was calculated as a function of the applied magnetic field H with a constant superconductor width, and also as a function of the width D with a constant applied field. In low fields, loss L was proportional to $H^{3.5}$, while in high fields, to $H^{0.6}$. When the width of the superconductor was small, loss L was proportional to $D^{1.3}$. Based on the calculated curves mentioned above, the loss of a coil was calculated in a simplified condition where the applied magnetic field was equal on both sides of any one layer. (auth)

13408 JOSEPHSON EFFECT AND THE FLUX QUANTIZATION IN SUPERCONDUCTORS. Fricsovszky, Gyorgy; Kirschner, Istvan; Kondor, Imre. Fiz. Szemle, 17: 298-303(Oct. 1967). (In Hungarian).

The experimental study of the tunnel effect occurring between a superconducting and a normal metal, was initiated by I. Giaever in 1960. Two years later, B. O. Josephson showed that a new type of tunnel current is generated by Cooper pairs in tunnel diodes consisting of two superconducting metals separated by a thin insulating layer. The superconducting system is characterized by phase coherence at macroscopic distances. The phenomenon is examined theoretically from different points of view. The phenomenological approach presents the difficulty that the phase dependence of the current density can be derived only from the microscopic theory, while the very important proximity effect may be explained only within the framework of the Ginzburg–Landau theory. The microscopic theory itself is based, among others, on the tunneling Hamiltonian system; the processes within the insulating layer are described by means of the Green-function method of the quantum-mechanical many-body problem. A simple, two-energy level model is described, citing experiments which support the quantization of the flux. (TTT)

13409 FIRST-SOUND DISPERSION PRODUCED IN ^{4}He BY DECELERATION OF THE NORMAL COMPONENT. Esel'son, B. N.; Dyumin, N. E.; Rudavskii, E. Ya.; Serbin, I. A. (Inst. of Low Temperatures of Physics and Tech., Kiev). JETP Lett. (USSR) (Engl. Transl.), 6: 243-5(Oct. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 783-7(Oct. 15, 1967).

The temperature dependence of the velocity of first sound propagating in ^{4}He in a system of branched channel formed by corundum powder with average particle dimension 28 μ was measured. (M.O.W.)

13410 RESISTANCE OF A THIN SUPERCONDUCTING CURRENT CARRYING FILAMENT. Shmidt, V. V. (Baikov Inst. of Metallurgy, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 257-9(Oct. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 804-7(Oct. 15, 1967).

The resistance of a thin superconducting current-carrying filament without a magnetic field, with allowance for the temperature fluctuations, was investigated. (M.O.W.)

13411 EXPERIMENTAL EVIDENCE FOR A DEPENDENCE OF THE KAPITZA CONDUCTANCE ON THE DEBYE TEMPERATURE OF A SOLID. Challis, L. J. (Univ. of Nottingham, Eng.). Phys. Lett., 26A: 105-6(Jan. 1, 1968).

It is shown that there appears to be a significant correlation between the Kapitza conductance of a solid and the reciprocal of its Debye temperature but with a linear dependence rather than the cubic dependence of Khalatnikov's theory. (auth)

13412 THERMODYNAMICS OF WEAKLY CONNECTED SUPERCONDUCTING RINGS. Nakajima, S.; Kuroda, Y. (Tokyo Univ.). Phys. Lett., 26A: 106-7(Jan. 1, 1968).

A thermodynamical analysis is made of the magnetization of weakly connected superconducting rings as observed by Silver and Zimmerman. A possible decay of the persistent current is predicted. (auth)

13413 CRITICAL SURFACE CURRENT OF A TYPE-II SUPERCONDUCTOR. Lowell, J. (Clarendon Lab., Oxford). Phys. Lett., 26A: 111-12(Jan. 1, 1968).

The maximum lossless transport current in a sample of low-defect-density type-II superconductor appears to be determined by interaction of the fluxoids with the surface, and not by the capacity of a surface region to support current. (auth)

13414 THE SKIN EFFECT. III. THE SKIN EFFECT IN SUPERCONDUCTORS. Casimir, H. B. G. (N. V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands); Ubbink, J. Philips Tech. Rev., 28: 366-81(1967).

This last of a series of three articles on the skin effect deals with the penetration of an electromagnetic field in the surface of a superconductor. In the two-fluid model, the superconductor contains "superconducting" and "normal" electrons. The supercurrent, obeying the London equations instead of Ohm's law, is proportional to the vector potential. The superconducting electrons cause the screening, even at zero frequency, and the normal electrons in the skin layer cause the absorption at nonzero frequency. The "London penetration depth" is independent of frequency. Among the proposed modifications to this model special attention is paid to the one put forward by Pippard, in which the London relation between current and vector potential is replaced by a nonlocal relation. This theory runs parallel with that of the anomalous skin effect, discussed in part II. A characteristic quantity occurring in Pippard's theory (and elsewhere) is the "coherence length." By comparing this with the penetration depth it is possible to divide superconductors into different types. Experimental results relating both to the penetration depth and the surface absorption support this refinement. The type of superconductor in which the field penetration is limited to a skin layer has been

used to make high-Q resonant cavities, and is possibly applicable in linear accelerators. (auth)

13415 THERMODYNAMICS OF TYPE-II SUPERCONDUCTORS. I. Fournet, G. (Laboratoire Central des Industries Electriques, Fontenay-aux-Roses, France. Faculte des Sciences, Paris). J. Phys. (Paris), 28: 881-6(Nov.-Dec. 1967). (In French).

It is shown that knowledge of the function $\omega(s,T)$ relative to the supplementary free energy (per unit length) due to the presence of a vortex of section s allows one to obtain the various parameters $H_{c1}(T)$, $H_{c2}(T)$, $H_c(T)$, $\varkappa_1(T)$ relative to an ideal type-II superconductor. (auth)

13416 DIRECT PROOF OF FLUX LINE MOTION IN CURRENT TRANSPORT THROUGH SUPERCONDUCTORS. Traeuble, H.; Essmann, U. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Phys. Status Solidi, 25: 395-402 (Jan. 1, 1968). (In German).

Under the influence of a transversal magnetic field superconductive lead foils with a thickness of $d \leq 0.05$ mm show a magnetic structure that consists of macro flux lines with about 50 fluxoid quanta per flux line. If a sufficiently high transport current is driven through the foil normally to the field orientation, the flux lines move in discrete paths under a Hall angle α. Dislocations and grain boundaries considerably influence the movement of the flux lines. (auth)

13417 SUPERCONDUCTIVE CURRENT IN A SUPERCONDUCTOR/NORMAL METAL/SUPERCONDUCTOR JUNCTION. Yeh, R. H. T.; Mechetti, H. (Univ. of Virginia, Charlottesville). Phys. Status Solidi, 25: K65-6(Jan. 1, 1968).

An equation relating the superconductive current in a superconductor/normal metal/superconductor junction to various parameters is derived from the Ginzburg–Landau equation. The equation is incorrect for very small and very large thicknesses of the normal layer, but otherwise the results have been generally confirmed experimentally. (A.G.W.)

13418 IMPROVEMENTS IN OR RELATING TO LIQUID LEVEL GAUGES. Atkinson, Harry Hindmarsh (to National Inst. for Research in Nuclear Science). British Patent 1,096,025. Dec. 20, 1967. Filed Oct. 24, 1963.

A gage for measuring the level of a cold liquid having a temperature such that a material immersed in the liquid becomes superconducting is described. An electrically conducting loop is immersed in the liquid, and a current is passed through the loop which is just sufficient to maintain the boundary between the superconducting and the normal states of the loop. The resistance of the wire loop is measured, and the liquid level is determined from this measurement. (W.H.K.)

13419 SAFETY WITH CRYOGENIC FLUIDS. Zabetakis, Michael G. The International Cryogenics Monograph Series. New York, Plenum Press, 1967. 168p. $11.50.

This book presents in concise form the safety principles of cryogenic fluids handling. Safety rules, design data, first-aid precautions, and hazard-control procedures are covered. Emphasis is placed on basic principles. (D.L.C.)

13420 SOLUTION OF GINZBURG-LANDAU EQUATIONS FOR ARBITRARY TANGENTIAL MAGNETIC FIELDS: EXPERIMENTAL VERIFICATION WITH SUPERCONDUCTING TRANSMISSION LINE. Alphonse, Gerard A. Brooklyn, N. Y., Polytechnic Inst. of Brooklyn, 1967. 125p.

Thesis.

The purpose of this dissertation is to determine the dependence of the Ginzburg–Landau (G–L) order parameter on arbitrary tangential magnetic fields, and to experimentally measure it, hence verifying the validity of the theory. In this work the G–L equations are solved for superconductors in the presence of arbitrary tangential fields. It is shown that if the thickness of the specimen is less than the size of Abrikosov's vortices, the equations can be linearized without the usual assumption of zero coupling constant k, and the (reduced) order parameter Φ is magnetic field dependent, but essentially independent of coordinates. For symmetrical fields on films of finite thickness d our solution gives the same results as found by Ginzburg and Landau for $k = 0$: the magnetic transition is second order (i.e., the order parameter goes smoothly to zero) for $d < \sqrt{3}\,\lambda(T,0)$, where $\lambda(T,0)$ is the temperature dependent penetration depth, whereas it is first order (i.e., the order parameter jumps discontinuously to zero) for $d < \sqrt{3}\,\lambda(T,0)$. For unsymmetrical fields the transition is always first-order, and the amount of the discontinuous jump depends on the degree of asymmetry of the fields. In the case where the asymmetric field is a superposition of an external field and the field due to transport current in the superconductor, the critical order parameter is shown to vary as a two-third power function of the current, with a maximum value of $\sqrt[2]{3}$. A superconducting transmission line has been devised and found to fulfill the magnetic boundary conditions when it carries current while located in the field of a solenoid. By calculating the parameters of the line using the London theory and relating them to the order parameter, it is found that the square of the order parameter is directly proportional to the resonant frequency of a section of the line. The measurement of this resonant frequency thus provides an elegant method of measuring the order parameter and its dependence on various physical quantities, including magnetic field. An experiment is devised using this approach to verify the results described in the preceding paragraph; the measurements show striking agreement between the experimental data and those calculated from the G–L theory. These measurements not only provide a verification of the G–L theory with the London theory, but also provide a general and versatile method for studying properties of superconductors. Finally, it is shown that since a superconducting line is nonlinear it can have useful applications as a parametric device. Expressions for the gain of a superconducting traveling wave amplifier are derived and some experimental results are presented. The superconducting TWA is shown to be a potentially low-noise device. (Disser. Abstr.)

13421 SUPERCONDUCTIVITY IN SMALL SYSTEMS. Groff, Ronald Parke. Rochester, N. Y., Univ. of Rochester, 1967. 172p.

Thesis.

It has been demonstrated by Little and Parks that the superconducting transition temperature T_c of a multiply connected superconductor is periodic in applied magnetic flux with periodicity hc/2e. However, because of various difficulties which were concerned mainly with sample preparation, the early experiments provided little more than a qualitative check of the theory of the critical field behavior of superconducting microcylinders. The primary objective of the present work was the fabrication of improved cylinders of the Little–Parks type in order that quantitative comparisons could be made between theory and experiment. By going to improved samples it was possible to construct detailed phase diagrams (critical field vs temperature) for Al and Sn microcylinders which are in good agreement with predictions of the linearized Ginzburg–Landau theory. A second aspect of the present study is that it provides information about current-induced depairing in superconductors which is not accessible in other types of experiments. This facet of the results is discussed within the framework of the generalized depairing theory. Finally, a discussion of thermodynamic fluctuations in superconductors is presented and it is pointed out how such fluctuations interfere with experiments on small superconducting systems. (Disser. Abstr.)

13422 INTERNAL PROPERTIES OF ABRIKOSOV FLUXOIDS IN TYPE-II SUPERCONDUCTORS. Leadon, Roland Eugene. San Diego, Calif., Univ. of California, 1967. 148p.

Thesis.

The Green's function equations for superconductivity, as developed by Gorkov, have been used to study some internal properties of Abrikosov fluxoids in type-II superconductors. Approximate Green's functions for a bulk pure superconductor with one fluxoid have been obtained by a modification of Werthamer's theory for "local" superconductivity. These Green's functions predict a finite local density of states near the fluxoids for all energies, including those less than the local-order parameter $\Delta(r)$. The total density of states near the Fermi energy due to one fluxoid is equal to the density of states for a cylinder of normal metal with a radius of about one coherence distance, ξ_0, in agreement with Caroli et al. The densities of states were used to estimate the effect of fluxoids on the nuclear spin relaxation rate for type-II superconductors. For temperatures near the critical temperature T_c, the relaxation for a superconductor with fluxoids is less than the rate for a uniform superconductor. At very low temperatures, the rate is greater than for the uniform superconductor. Both of these trends are in agreement with the experimental results of Silbernagel. Equations for the distribution of charge density and electrostatic fields throughout a fluxoid were obtained by expanding the Green's functions of the system in powers of the order parameter, similar to the technique used by Gorkov in his microscopic derivation of the Ginzburg–Landau equations. At fairly large distances from the fluxoid, where the order parameter is essentially constant, the derived equations agree with the result of Van Vijfeijken and Staas for the electric field in a fluxoid. However, close to the fluxoid, there are significant differences between the two results. The maximum values of the electrostatic fields appear to be quite small and should be negligible for most calculations. (Disser. Abstr.)

13423 STUDIES OF ac LOSSES AND MAGNETIZATION OF SUPERCONDUCTING WIRES. Taylor III, Henry Fuller. Houston, Tex., Rice Univ., 1967. 94p.

Thesis.

Alternating-current induced voltages and energy losses observed for superconducting wires are compared with predictions based on Bean's model. Magnetization data for wires subject to an axially applied magnetic field are compared with magnetization curves predicted by Bean's model. Observations of anomalous energy loss and magnetization behavior for the case of ac flowing in an applied axial field are explained on the basis of a "semi-force-free" model. Good agreement between ac loss data and Bean's model theoretical curves is found for Nb, Nb−25% Zr, Nb−33% Zr, and Nb−50% Ti wires. The critical current density function is assumed to have the form $J_{sc} = \alpha/(B_0 + B_\theta)$, with α and B_0 adjustable parameters. The data for Pb and Pb−60% Sn wires do not yield to any such Bean's model fit. Experimental magnetization curves for Nb−25% Zr wire samples are found to fit Bean's model curves predicted for the case that $J_{\theta c} = 7.5 \times 10^3$ amps cm^2 = constant. Observations for the case of a Nb−25% Zr wire carrying ac in an axial field cannot be explained on the basis of Bean's model. It is found that the application of an axial field results in reduced ac losses and that turning on ac causes a paramagnetic shift in the wire's time-averaged magnetic moment. An alternating component of magnetic moment is observed if ac and an applied field are both present. A model is proposed to explain these results. Briefly, the model assumes that the wire can support increased current densities because the current tends to flow in "semi-force-free" fashion such that the angle between $\vec{J}$ and $\vec{B}$ is small. An increase in current densities would lead to a decrease in ac losses, and "semi-force-free" current flow would lead to a paramagnetic shift in the magnetic moment of the wire. (Disser. Abstr.)

13424 MECHANICAL MEASUREMENT OF THE ENERGY DISSIPATION ASSOCIATED WITH THE MOTION OF MAGNETIC FLUX THROUGH SUPERCONDUCTING INDIUM STRIPS AND FILMS. Smith, David Robert Jr. Houston, Tex., Rice Univ., 1967. 96p.

Thesis

A torsion pendulum was used to measure the energy dissipation occurring in strips and in vacuum-deposited films of indium as a function of the velocity with which they moved through a magnetic field. Measurements were made both above and below the superconducting transition temperature T_c. No dissipation was observed either above or below T_c when the strips moved through a uniform magnetic field applied in a direction perpendicular to the motion. Energy losses were observed above T_c when the strips moved through small localized, inhomogeneous magnetic fields. These losses, presumably due to eddy currents, were not observed with the films because of their small volumes. Below T_c energy dissipation occurred in both the strips and the films when they moved through the localized fields. The energy loss below T_c contains a part proportional to the velocity with which the indium samples pass through the fields and velocity independent part. Both parts were observed with the strips, but only the velocity independent part was observed with the films. The losses below T_c were at least an order of magnitude larger than those above T_c for the same field intensity. An analysis of the velocity-dependent part of the losses is made by assuming that the flux passes through the strips in bundles of radius a, and experimental viscosity coefficients are calculated in terms of a^2. A theoretical relation for the viscosity coefficient is derived for a moving flux bundle in a type-I superconductor. It is shown that the electric field inside the bundle is uniform and equal to $v_L H_c/c$, where v_L is the speed of the moving bundle, H_c is the thermodynamic critical field, and c is the speed of light. The experimental viscosity coefficients are compared to the theoretical relation and the normal state conductivities are computed. (Disser. Abstr.)

Plasma and Thermonuclear Physics

13425 (AED-C-03-14) DOCUMENTATION OF PLASMA PHYSICS. PART 1. EXPERIMENTAL PLASMA PHYSICS, THEORETICAL PLASMA PHYSICS. Bibliography, Author Index, Subject Index. Volume 2. Hilsenbeck, D. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Nov. 1967. 212p. Dep.

A listing of 370 articles on various aspects of plasma physics is presented. Author and subject indexes are included. (M.O.W.)

Confinement and Heating of Plasma

13426 (67-C-252) THETA PINCH LEAD DESIGN FOR MINIMUM FIELD DISTORTION. Goldman, L. M.; Kilb, R. W.; Westendorp, W. F. (General Electric Co., Schenectady, N. Y. Research and Development Center). July 1967. 14p.

The purpose of this study was to reduce the azimuthal asymmetry of the magnetic field in theta pinch coils. In uniform coils one can obtain reasonable field symmetry with a simple lead. This does not work for mirror coils because the current distribution on the inside coil surface is extremely nonuniform. The current distribution in azimuthally symmetric coils is found by simulating the coil with a set of current loops. The current distribution in the tab should then match the axisymmetric coil current distribution. The current in the tab must also approach the coil perpendicularly on the inner and end surfaces so that the field lines remain parallel to the coil surface at the tab-coil junction. The tab current distribution is controlled by profiling the gap spacing. The spacing should be inversely proportional to current density. Experiments showed that by appropriate shaping of the gap, the asymmetry $\Delta B_z/B_z$ across the coil diameter was reduced by a factor of ~20 from the previous tapered lead, to a level of $\Delta B_z/B_z \sim 1/1000$ over nearly the whole length of the coil. (auth)

13427 (CLM-R-76) COMPUTED DATA FOR PHOENIX II: PLASMA DENSITY AND VELOCITY DISTRIBUTIONS, SINGLE PARTICLE BEHAVIOUR, AND DETECTOR EFFICIENCIES. Kuo-Petravic, G.; Petravic, M.; Riviere, A. C.; Steed, C. A.; Sweetman, D. R. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Sept. 1967. 22p. Dep. CFSTI. UK 3s. 6d.

The advent of complex field configurations to produce magnetic wells has made desirable a simple method of describing the plasma distribution. One such method is described which essentially gives the plasma distribution in terms of the axial adiabatic invariant (J) and the precessional drift surface described by the radius of a flux tube. Plasma distributions in this two dimensional space are plotted for typical Phoenix-II injection conditions and, using similar computer programs, the efficiency of neutral particle emission detectors is calculated. Other properties such as the average anisotropy and precessional drift frequency have been computed. (auth)

13428 (NP-17257) TRANSVERSE PLASMA TRANSPORT DUE TO DRIFT WAVES IN A MAGNETOPLASMA. Report No. 37. Josephy, Karl (Columbia Univ., New York. Plasma Lab.). 1967. 108p.

The transverse diffusion constant $D_\perp$ of an alkali-metal Q-machine plasma with number density $\sim 10^9$ cm^{-3} was observed to depend strongly on the presence of low-frequency drift waves in the plasma. The waves either occurred naturally or were driven by the application of an ac voltage to a plasma termination. Probe measurements identified the wave as a drift wave traveling in the electron Larmor drift direction. Electron sheaths at the endplate obtained either by increasing the hot plate temperature or by applying a positive voltage of 1 to 2 volts to the cold endplate, reduced the amplitude of the naturally occurring drift waves. With all other parameters held constant, the application of +1 volt to the cold endplate reduced $D_\perp$ by a factor of 100 to a value close to the classical value of $D_\perp$. It was found that the transverse diffusion could be increased by a factor of 10 by the application of an ac potential to the cold endplate at the frequency of the naturally occurring drift wave. At frequencies other than the drift wave frequencies, the increase in $D_\perp$ was much lower. An equation for the radial variation of the drift wave potential was obtained and solved on a computer for a cylindrical plasma with a radial number density gradient and bounded by a metal radial boundary. The solutions give both the radial variation of the potential and the dispersion equation relating ω and k_z. For $k_z = 0$ we do not obtain integrally related harmonics, as was the case for previous theories. The measured radial potential variation for both naturally occurring and driven drift waves are in qualitative agreement with the computer results. (auth)

13429 (UCRL-70656) PLASMA CONTAINMENT IN THE 2X EXPERIMENT. Coensgen, F. H.; Cummins, W. F.; Ellis, R. E.; Kovar, F. R.; Nexsen, W. E. Jr. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1, 1967. Contract W-7405-eng-48. 17p. (CONF-671127-1). Dep. CFSTI.

From International Conference on Plasma Confined in Open-Ended Geometry, Gatlinburg, Tenn.

In the 2X experiment, plasma containment in open-ended systems is studied by rapidly creating a plasma then making time dependent measurements of density, ion energy, electron temperature, end losses, cross field transport, radiation, etc Although low order interchange instabilities were suppressed in simple mirror systems by line-tying, higher order modes persisted so that it was impossible to evaluate the contribution of high frequency fluctuations to the observed anomalously rapid plasma loss. With conventional vacuum conditions (base pressure ~5 × 10^{-7} torr) attempts to suppress the low frequency instabilities by

transforming to a minimum-B containment field after the plasma was trapped encountered a very rapid plasma loss which was found to be associated with an influx of neutral gas. By reducing the base pressure to the 10^{-9} torr range and evaporating titanium throughout the entire chamber the neutral influx was reduced and at least one instability suppressed. Thus plasma with density up to 5×10^{13} cm^{-3} was injected under conditions where lifetime in a quasi-stationary minimum-B field was not limited by ion-ion scattering, electron cooling, charge exchange or interchange instabilities. From the presence of high frequency fluctuations, sporadic end loss and anomalously high attenuation of transmitted microwave beams the plasma is known to be turbulent. In the range from 3×10^{13} to 5×10^{12} cm^{-3} the characteristic decay time was between 350 and 500 μsec. Below 5×10^{12} cm^{-3} the density decay proceeds in an obviously stepwise fashion, indicating intermittent stability. Evidence suggests that the stabilizing effect was also present at higher densities but that the length of the stable periods decreases with increasing density. (auth)

13430 (MATT-Trans-46) DIVERTOR OF THE "SIRIUS" STELLARATOR. Biryukov, O. V.; Georgievskii, A. V.; Ziser, V. E.; Kravchin, B. U.; Kitaevskii, L. Kh.; Pogozhev, D. P.; Sergeev, Yu. F.; Tolok, V. T. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Plasma Physics Lab., Princeton Univ., N. J., from a Russian report. 34p. Dep. CFSTI. JCL $3.60 fs, $0.95 mf.

The basic parameters and structural features of the divertor of the Sirius stellarator are presented. Investigation of the topology of the magnetic field of the divertor by the electron beam method has revealed good comparison between the calculated and experimental results. It is proposed that plasma be injected into a closed magnetic system through a divertor. (auth)

13431 STATUS OF CONTROLLED THERMONUCLEAR RESEARCH. Van Atta, C. M. (Univ. of California [Livermore]). pp 257-78 of Advanced Propulsion Concepts. New York, Gordon and Breach, Science Publishers, Inc., 1966.

From 4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif. See CONF-650416-(Vol.2).

The various experimental devices and techniques presently in use for controlled thermonuclear research are briefly described. (M.O.W.)

13432 NUCLEAR FUSION REACTOR. Hansen, S.; Fonda-Bonardi, G. (to Litton Industries, Inc.). Canadian Patent 765,041. Aug. 8, 1967.

This nuclear fusion reactor uses plasma masses accelerated by magnetic fields which are directed to collide in a predetermined area. Deuterium and tritium nuclei, if they acquire sufficient kinetic energy fuse to form ^{4}He ions and a neutron. An arrangement is described which favors collision and fusion. Particles which fail to fuse are recycled. The energy of the fast neutrons resulting from fusion is absorbed in a shield such as graphite where the heat is converted to electrical power by conventional means. This accounts for about 80% of the fusion energy. The remainder which is carried by the helium ions and electrons is used to produce a voltage in a field coil suitably located. As this is not a thermonuclear reaction, problems caused by high temperature are avoided. (F.S.A.)

13433 ANNULAR CONFINEMENT OF HIGH-TEMPERATURE PLASMAS. Furth, Harold P. (to United States Atomic Energy Commission). U. S. Patent 3,369,140. Feb. 13, 1968.

This patent relates to an apparatus for providing plasma confinement stable against interchange modes in which an annular plasma confinement zone has a non-zero field strength. Spaced magnet coils form the appropriate magnetic field between coils in which confinement occurs. (auth)

13434 APPLICATION OF RADIO FREQUENCY ELECTROMAGNETIC FIELDS TO HEAT AND CONTROL THE STATE OF A FLOWING PLASMA. Vermeulen, Peter James. Houston, Tex., Rice Univ., 1967. 119p.

Thesis.

The argon plasma produced by a dc arc jet was reheated in a cylindrical quartz by means of an inductive radio-frequency field. The plasma temperature distribution was studied experimentally and analytically, and was shown to be significantly affected by the rf field. The successful coupling of an rf field to a plasma jet excites immediate interest in that the specific thrust of an electrothermal propulsor can be increased; moreover it may be possible to use the rf "skin effect" to control the temperature distribution to advantage, and hence produce a plasma of more uniform properties. Experiments were conducted at atmospheric pressure and at low subsonic velocities. The temperature distributions of the flow were measured spectroscopically and encouraging evidence of state control in the transition regime was obtained. However a refined temperature measurement technique must first be developed in order to obtain conclusive evidence. The maximum temperature measured was about 11,340°K(±5%), and energy transfers were such that about 4 kW was transferred to the plasma in both the dc and rf sections. A numerical solution of the nonlinear ordinary differential equations, for the magnetic field and energy equations, having temperature-dependent properties and representing a fully developed steady flow model, was obtained. Reasonable agreement was found between the theoretical prediction and measurement of the plasma heat transfer. The agreement for the boundary magnetic field strength is poor (discrepancy of a factor of 3.5), and consequently the measurement is suspect. Furthermore the theoretical results show that the temperature distribution can be controlled towards a uniform value by varying the field frequency. (Disser. Abstr.)

Diagnostics of Plasma

13435 (FEI-20) DIAGNOSTIKA NIZKOTEMPERATURNOI TSEZIEVOI PLAZMY. (Diagnostics of Low-Temperature Cesium Plasma). Volkov, N. V.; Gus'kov, Yu. K.; Pashchenko, V. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Tekhnicheskii Institut). 1965. 15p. (In Russian). Dep.

The experimental unit consists of a molybdenum cathode 12 mm in diameter heated by an electron beam. Its temperature is measured by means of two Ta-Re thermocouples in niobium jackets. The temperature of the stainless steel anode 12 mm in diameter is measured by a chromel-alumel thermocouple. A movable molybdenum probe 0.35 mm in diameter and covered with Al_2O_3 was used to measure the volt-ampere characteristics. It was possible to determine the distribution of potential in the diode space, the concentration and temperature of the electrons. The results were compared with those predicted by theory. It was found that the calculated and experimental values of the electron concentrations were in good agreement. For small potential jumps of <0.5 eV the calculated and experimental values of the plasma potential and electron temperature showed good agreement. Edge effects had a considerable effect on the electron temperature. This method is suitable for investigating a plasma in the predischarge state, that is, before transition of the converter into the arc mode of operation. (TTT)

13436 (LRP-33/67) MESURES DE DENSITE ELECTRONIQUE DANS UNE DECHARGE AXIALE DE PREIONISATION A L'AIDE D'UN INTERFEROMETRE AMELIORE. (Measurements of Electron Density in a Pre-Ionized Axial Discharge by Means of an Improved Spectrometer). Heym, A. (Laboratoire de Recherches sur la Physique des Plasmas, Lausanne (Switzerland)). Nov. 1967. 18p. (In French). Dep.

A Mach-Zehnder interferometer is described which is used for electron line density measurements of a rapidly varying plasma. The density profile of the plasma is obtained by scanning a 3-mm-wide He-Ne laser beam across the diameter of the discharge tube. Fringe detection is made with a system of two photomultipliers which allows one to follow the sense of variation of the electron line density in an unambiguous manner. This interferometer is used to measure the electron line density of an axial current discharge in 25 mtorr H_2. Complete ionization of the gas is found after 9 μsec. The gas remains in a fully ionized state until the discharge current is crowbarred. Electron loss is observed to be governed by ambipolar diffusion for time greater than 10 μsec after crowbar. (auth)

13437 (LRP-36/67) MESURES DE LA DENSITE ELECTRONIQUE DANS UNE STRICTION A CHAMP TOURNANT A HAUTE FREQUENCE. (Measurement of Electronic Density in a Pinch with a Field Rotating at High Frequency). Heym, A. (Laboratoire de Recherches sur la Physique des Plasmas, Lausanne (Switzerland)). Dec. 1967. 14p. (In French). Dep.

Two high-power generators deliver rf pulses, each of which consists of 8 periods at a frequency of 2 Mc. In a tube of 5-cm diameter and 50-cm length, one generator produces an axial current of 18-kA peak amplitude while the other, which feeds a 3-turn coil, induces an azimuthal current of 56-kA peak amplitude in the plasma. When the two currents are dephased by 90°, the plasma experiences a rotating magnetic field of 1.8 kG. Axial streak pictures of the plasma were taken, and the temporal and spatial variations of the electron line density were measured with a Mach-Zehnder interferometer. This apparatus is equipped with a photomultiplier detection system which allows the electron line density to be measured without ambiguity. The sensitivity of the device is approximately 5×10^{13} cm^{-3}. These measurements were made in 25-mtorr He which was preionized by an axial current pulse of 13-kA amplitude and 15-μsec duration. The formation of a pinch is demonstrated. The electron density on the axis of the discharge

tube grows during the first two microseconds until the value of 1.15×10^{16} cm^{-3} is reached. At this time the density within 4 mm of the wall is lower than 5×10^{13} cm^{-3} and the integral of the electron density over the cross section indicates complete ionization. After about 2.5 μsec the current returns to the wall. Simultaneously evolution of gas from the wall is observed. The possible correlation of these two phenomena is discussed. (auth)

13438 (NP-17214) DETERMINATION SPECTROSCOPIQUE DE LA DENSITE ET DE LA TEMPERATURE ELECTRONIQUES D'UN PLASMA D'HYDROGENE. (Spectrographic Determination of the Density and Electronic Temperature of a Hydrogen Plasma). Van Hauwermeiren, R. (Brussels Univ. (Belgium). Faculte des Sciences). 1967. 222p. (In French). Dep.

Thesis.

A technique for the measurement of the electron density and temperature that is simple and systematic so that the magnitudes can be determined on a single phenomenon and which makes it possible to follow their evolution during the course of time was developed. A detailed investigation was then made of the phenomena absent in the density and temperature region considered. The spectroscopic methods used for the determination of the density and temperature are described and a new method for the density determination was developed. The design and construction of apparatus for this method is described. The results show that the method of determining the electron density by the ratio of the intensity of a H_β line measured with two lengths of different slope gives reproducible results to ±15%. This determination is in good agreement with the measurements of the electron density derived from the evaluation of the half length of the ray profile given point by point. Experimental results show that the temperature measured by the method of three channels is valid in the case where the impurities have little effect on the spectra in the regions studied. Measurements on impurity lines lead to the assumption that their density can be very strong and that the atoms should play a nonnegligible role in the dynamics of the phenomena. (J.S.R.)

13439 (ORO-3393-3) APPLICATIONS OF LIGHT SCATTERING TO PLASMA DIAGNOSTICS. Progress Report. Griem, Hans R. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Dec. 1967. Contract AT(40-1)-3393. 86p. Dep. CFSTI.

Six sections are included: (1) A description of the low-field, large-volume theta pinch on which most of the light scattering and spectroscopic experiments have been performed; (2) A preprint of a paper to appear in The Physical Review on measured collisional rate coefficients for helium-like carbon ions; (3) A preprint of a paper to appear in The Physics of Fluids on the determination of electron temperatures and densities from helium-like ion line emission; (4) A note on impurity determinations; (5) A note on operation with low-pressure methane fillings; (6) A status report for the high-electron-density–low-temperature light scattering experiment. (auth)

13440 IONIZATION OF FAST NEUTRAL ATOMS BY PASSAGE THROUGH A HOT-CATHODE DISCHARGE. Fleischmann, H. H.; Kribel, R. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Rev. Sci. Instrum., 39: 233-8 (Feb. 1968).

The possibilities and conditions for ionization of neutral hydrogen atoms in the energy range of 30 to 300 eV by passage through an auxiliary plasma are investigated. The general requirements for the plasma are determined by the scattering of the fast neutrals and ions to be detected: density, integrated along the path of the fast particles, several $\times 10^{12}$ cm^{-2}; integrated neutral density $\gtrsim 10^{15}$ cm^{-3}; electric fields $\lesssim 1$ V cm^{-1}; and magnetic fields not more than a few hundred gauss. In this case, usable conversion ratios of several 10^{-3} seem possible. Experimentally, the conversion efficiency of a plasma produced by a hot-cathode discharge is compared with the efficiency of a calibrated air stripping cell. At low energies, for the plasma cell, higher efficiencies by about an order of magnitude are found. Expected values for the conversion efficiencies are achieved for particle energies above 250 eV. At lower energies, similar values seem achievable using ion analyzers with wide acceptance angle. (auth)

13441 LASER APPLICATION FOR PLASMA RESEARCH. Yamanaka, Chiyoe; Yokoyama, Masahiro; Yamanaka, Tatsuhiko; Izawa, Yasukazu; Tsuchimori, Noriyuki (Osaka Univ., Japan). Lasers Opt. Non. Conv., No. 7, 54-6 (1967).

The use of lasers for measuring electron density in shock-produced plasma, and for producing plasmas from solids is briefly described. (M.O.W.)

13442 TWO-WAVELENGTH PLASMA INTERFEROMETRY WITH COLOR FILM. Panarella, E.; Guty, V. (National Research Council, Ottawa). Rev. Sci. Instrum., 39: 261-2 (Feb. 1968).

The technique involved in plasma electron density measurement using two-wavelength interferometry is described. (M.O.W.)

13443 IONIZING SHOCK WAVE PLASMA DIAGNOSTICS. Miller, B.; Marshall, T.; Gross, R. A. (Columbia Univ. [New York]). pp 71-88 of Advanced Propulsion Concepts. New York, Gordon and Breach, Science Publishers, Inc., 1966.

From 4th Symposium on Advanced Propulsion Concepts, Palo Alto, Calif. See CONF-650416-(Vol.2).

The measurements of plasma properties and their associated electromagnetic fields are a complex and difficult experimental problem. In the following text we carefully examine an old problem, that of measuring with a probe the magnetic field in a plasma which is moving with respect to the probe. We show that the usual integration with respect to time is, in general, not proper and we develop the correct expressions for the case of a plasma and its associated fields produced by a strong shock wave in an electromagnetically driven shock tube. We also set forth the fundamental relationships for the relatively new technique of measuring electron density by the use of coherent light. Both these techniques are particularly relevant to measurements of dense, hot, transient plasmas, such as those generated by strong ionizing shock waves. (auth)

13444 FIRST-ORDER EFFECTS OF PRODUCTION ON THE CONTINUUM THEORY OF SPHERICAL ELECTROSTATIC PROBES. Cohen, Ira M.; Schweitzer, S. (Univ. of Pennsylvania, Philadelphia). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 298-304 (Feb. 1968).

The analysis of spherical Langmuir probes that are immersed in an infinite, homogeneous, slightly ionized, collision-dominated plasma is given to first order in the smallness of a parameter characterizing the effects of ionization and recombination. The treatment is given as a double limit: mean free path ≪ sheath thickness ≪ probe radius (as in the antecedent works) and the weakness of production effects. The first limit separates the system of equations into two regions: a quasi-neutral region and a thin collision-dominated space charge sheath. The second limit of weak production further separates the quasi-neutral region into two subsidiary regions: a main region in which the production effect is a regular perturbation and a distant region where gradients are weak and the small production is of the same order as diffusion. The governing diffusion equations are solved to lowest order in $\rho_p = r_p/\lambda_D$ and to first order in the smallness of the production parameter. Current–voltage characteristics are computed from integrals of the solutions, and emphasis is placed on their interpretation with respect to measurements. An experimental procedure is outlined which yields in turn D_-N_0, T_-/T_+, D_+/D_-, and the production parameter, where D is diffusion coefficient, T is temperature, and N_0 is the undisturbed ion or electron density. The first-order effects of ionization and recombination are also discussed. It is found for $T_-/T_+ = 1$ that, at negative probe potentials, the normalized ion current to the probe is increased and the electron current decreased. At positive probe potentials, on the other hand, the ion current to the probe is decreased and the electron current increased by the effect of production. For $T_-/T_+ > 1$, the same effect is observed for negative probe potentials, but for positive probe potentials no such general statement can be made. For a 10% change in the production parameter, for example, it is found that the relative change in the currents is at most slightly more than 10% (for fixed probe potential). (auth)

13445 BEAM SHAPE IN THE FOCAL REGION OF A MICROWAVE LENS AS DETERMINED FROM ENCIRCLED ENERGY. Richard, C.; Carswell, A. I.; Jassby, D. L. (RCA Victor Research Labs., Montreal). Appl. Opt., 7: 208-9 (Jan. 1968).

Contour calculations were made which contain constant percentage of the total beam energy. (M.O.W.)

13446 DOUBLE ELECTROSTATIC PROBES FOR FLAME DIAGNOSTICS. Malaczynski, G. (Inst. of Fluid-Flow Machines, Danzig). Bull. Acad. Pol. Sci., Ser. Sci. Tech., 15: 847-54 (1967).

The possibility of measuring the parameters of weakly ionized gases at elevated pressures, and particularly the degree of ionization, with the use of double electrostatic probes is discussed theoretically. (M.O.W.)

13447 ELECTRON CORRELATIONS IN PLASMA LINE BROADENING. Smith, Earl W. (Univ. of Florida, Gainesville). Phys. Rev., 166: 102-13 (Feb. 5, 1968).

A method of including electron correlations in the relaxation theory for spectral line broadening in plasmas is presented. The effect of these correlations in the relaxation theory is compared with the analogous results in the impact theory; numerical comparisons are made for the Lyman-α line of hydrogen. In partic-

ular, it is shown that the impact-parameter cutoff used in the impact theory constitutes a very good approximation to the effect of these correlations. (auth)

13448 SPECTROSCOPIC METHODS OF MEASUREMENT OF HIGH TEMPERATURES. Meunier, Maurice. Entropie, No. 13, 49-56(Jan.-Feb. 1967). (In French).

Spectroscopic methods used for measurement of temperatures between 1000 and 10,000°K in plasmas are described briefly. After a summary of conditions regulating the radiation of the plasmas, the case of optically thin mediums is distinguished from that of optically thick mediums. Only the general principles and the solutions eventually proposed or tried are considered. (auth)

13449 SPECTROGRAPHIC MEASUREMENTS OF ELECTRIC SHOCK TUBE FLOW. Barach, J. P.; Mayes, T. W. (Vanderbilt Univ., Nashville). Phys. Fluids., 11: 89-95(Jan. 1968).

A Kerr-cell shuttered spectrograph has been used to make measurements of the state of the plasma produced by an electric shock tube operating at high pressure (100 torr of CO_2). Relative line intensities have been used to measure the temperature and Stark broadening has been used to obtain the electron densities. The free-running plasma front is expected and found to be in local thermodynamic equilibrium. The complete state of the plasma flow is then deduced. Measured pressure, trajectory and density profiles approximate blast-wave calculations with, however, higher-pressure and lower-density values at the front than calculated from the Rankine–Hugoniot theory. The temperature profile does have a rising trend upstream, but the front temperature is much too high (a factor of four). Violent forward mixing of the arc gas, due to the deceleration of the front, accounts for this. An arc-produced photon precursor is assumed to dissociate the CO_2. (auth)

Kinetics of Plasma

Refer also to abstracts 13146 and 13309.

13450 (67-C-166) THETA-PINCH SHOCK IMPLOSION CALCULATIONS BY MODEL SIMULATION OF COLLISIONLESS ION VLASOV EQUATION. Kilb, R. W. (General Electric Co., Schenectady, N. Y. Research and Development Center). May 1967. 24p.

Computations describing the implosion phase of high-voltage, low-density theta pinches are carried out by using the collisionless Vlasov equation for the ions, and using the fluid equation for adiabatic electrons. The calculations are on a time scale long compared to the electron cyclotron time, but short compared to the ion cyclotron time. The equations are reduced to a set of equivalent cylindrical plasma sheets. The calculations show that the nonadiabatic ion heating in very-low-bias, negative-bias, and positive-bias theta pinches results from ion interaction with rapidly fluctuating electric and magnetic fields inside the plasma, and with the rapidly converging outside surface of the plasma. The mean ion energy was 1 keV at 2 μsec for very low bias and negative 1.5-kG bias, while it was only 0.6 keV for positive 1.5-kG. For very low bias the ion pressure is nonisotropic with $P_{rr} \gg P_{\theta\theta}$, and the density tends to peak on the axis. These effects do not occur for +1.5- and −1.5-kG bias. (auth)

13451 (LRP-35/67) APPAREIL DE MESURE DES PROPRIETES D'UN CHAMP MAGNETIQUE TOURNANT. (Apparatus for Measuring the Properties of a Rotating Magnetic Field). Jones, I. R.; Peiry, J-M.; Cocq, D. (Laboratoire de Recherches sur la Physique des Plasmas, Lausanne (Switzerland)). Dec. 1967. 36p. (In French). Dep.

An apparatus is described which allows one to measure the properties of a rotating magnetic field. This apparatus is used to monitor the field during the formation of a rotating field pinch. (auth)

13452 INFLUENCE OF A NONLINEAR IONIZED GAS LAYER ON THE PROPAGATION OF A PLANE ELECTROMAGNETIC FIELD. De Socio, Marialuisa. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 42: 656-61(May 1967). (In Italian).

The following theorem is stated: a plane electromagnetic field, traveling perpendicularly to a plasma layer, is not altered, in a second approximation, by the plasma. The theorem is verified even (1) when impacts among electrons and molecules are considered, (2) for nonhomogeneous plasma with density of the electrified particles which varies with the height, and (3) when a uniform magnetic field works perpendicularly to the plasma layer. (auth)

13453 PROPAGATION OF ELECTROMAGNETICALLY GENERATED SHOCK WAVES IN ARGON AND HELIUM. Hinrichs, J.; Kuttruff, H. (Univ., Goettingen, Ger.). Z. Angew. Phys., 24: 121-5(Feb. 1, 1968). (In German).

By means of a T tube, shock fronts in argon and helium are generated in a pressure range from 0.1- to 20-mm Hg. The maximal velocities correspond to Mach 60 and Mach 35, respectively. Using photomultipliers and magnetostrictive pressure probes the propagation of the driving plasma and the preceding shock front are investigated. The latter begins to separate from the plasma for velocities less than Mach 18 in argon and Mach 14 in helium. In this range the propagation of the shock front can be described by the blast wave theory ("homology solutions"). For higher shock velocities, however, the simple "snow-plough model" applies quite well. (auth)

13454 ON THE REVERSIBILITY OF THE VLASOV EQUATION. Heybey, Juergen. Beitr. Plasmaphys., 7: 357-69(1967). (In German).

The difference between LANDAU'S decaying solutions of the linearized VLASOV equation and the damped solutions of a loaded electrical circuit is shown. An integral equation for the field acting in the plasma is investigated and the LAPLACE transforms of its solutions are considered. Also, some simple initial-value problems for the CAUCHY distribution for a perturbation by external fields are solved. It is demonstrated that the time error in the behavior of measurable quantities of the VLASOV plasma stems from the accentuation of a nonprobable initial state. (auth)

13455 GOLDSTONE THEOREM FOR AN ELECTRON GAS IN A MAGNETIC FIELD. Morandi, G. (Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cim. (10), 53B: 216-21 (Jan. 11, 1968).

Since the original proposal by OVERHAUSER, static spiral spin-density wave (SDW) ground states (or equilibrium ensembles) have been extensively studied. The one-dimensional case at T = 0 has been studied and the spectrum of the collective modes has been completely computed within this RPA; finally, it has been proved that, within this approximation, the frequency of one collective branch vanishes when its wavelength equals that of the spiral. A similar theorem was proven in the three-dimensional case (also in the presence of a magnetic field) in the form of a rigorous result, independent of any approximations, as a consequence of the only fact that there is a broken symmetry in the problem, i.e. to show that $\omega(q) = 0$ when $q = Q$ (Q being the pitch of the spiral) is a consequence of Goldstone's theorem. (auth)

13456 PULSE-STIMULATED EMISSION FROM PLASMA COLUMNS. Baldwin, D. E.; Henderson, D. M.; Hirshfield, J. L. (Yale Univ., New Haven). Phys. Rev. Lett., 20: 314-17 (Feb. 5, 1968).

Experiment and theory are presented to show that pulse excitation of a cylindrical plasma produces decaying ringing at the electron-cyclotron frequency and at any upper hybrid frequency for which the electron-concentration gradient vanishes. In the absence of a dc magnetic field, the ringing occurs at the maximum plasma frequency. (auth)

13457 ION-WAVE ECHOES. Baker, D. R.; Ahern, N. R.; Wong, A. Y. (Univ. of California, Los Angeles). Phys. Rev. Lett., 20: 318-21(Feb. 5, 1968).

An experimental observation of ion-wave echoes which arise from the reversible nature of collisionless damping is reported. The results are described. (M.O.W.)

13458 INTERACTIONS OF ELECTRON AND ION BEAMS WITH POTASSIUM PLASMA. Buchel'nikova, N. S.; Kudryavtsev, A. M. Zh. Prikl. Mekh. Tekh. Fiz., No. 6, 50-5(Nov.-Dec. 1967). (In Russian).

Interactions of electron and proton beams with highly ionized plasma produced independently of the beams were studied. The design of the device used in the investigations is given. Diagrams of the plasma density distribution in units relative to the radius, spectral vibration of the plasma beam, spectra of plasma oscillations in various magnetic fields, and cyclotron frequency amplitudes as functions of the beam current and length of the cylinder are analyzed. (R.V.J.)

13459 ACCELERATION OF THE CURRENT LAYER IN A DENSE GAS. Musin, A. K. Zh. Prikl. Mekh. Tekh. Fiz., No. 6, 69-75(Nov.-Dec. 1967). (In Russian).

A layer of current flow in a rail-type plasma accelerator was studied, assuming that the dynamic resistance of the gas in the accelerator is identical to the magnitude of the electromagnetic forces. (R.V.J.)

13460 APPLICATION OF THERMAL PLASMA IN NUCLEAR TECHNOLOGY. Riedel, Jozef Tadeusz (Inst. of

Nuclear Research, Krakow). Przegl. Elektron., 8: 19-29 (Jan. 1967). (In Polish).

Further development of nuclear technology requires application of materials exhibiting high refractoriness, capability to absorb radiation, and high flame resistance. Hard, homogeneous, high-density, and very refractory surfaces may be obtained by means of plasma burners and high-melting powders. The method of generating plasma using argon gas is described. Radiation shields, such as concrete, are used to protect measuring instruments from neutron radiation. Current research on the development of radiation shields based on plasma techniques is described. Optical monochromatic pyrometers with filters are used to measure temperatures up to 9000°K; the approximate temperature may be calculated from the enthalpy, based on the energy balance in the plasma burner. When evaluating performance characteristics of plasma generators many parameters, such as the geometry of the burner's electrodes, availability and limitations of construction materials, cooling, thermal, and electrical efficiency must be considered. (TTT)

13461 THERMIONIC PLASMA PROCESSING. Riedel, Jozef Tadeusz (Nuclear Research Inst., Krakow). Przegl. Elektron., 8: 234-40(May 1967). (In Polish).

The physical and chemical properties of thermoelectric plasma are described. At normal temperature and pressure, the thermal gas is practically not ionized and the unexcited gas behaves like a perfect dielectric. The ionization of the gas is due mainly to an electric field or to the increase of gas temperature. At temperatures above 12,000°K, high electric conductivity is observed. With the increase of pressure and current density, transition to isothermal plasma takes place. In that state, there is thermal equilibrium between the plasma constituents, electrons, ions and neutral atoms. In the generalized case, the Boltzmann nonlinear equation is used to describe the behavior of plasma constituents. Plasma generators used in the industry and for research are also reviewed. Plasma arc temperatures of the order of 30,000°K and energies of 5000 kW may be obtained. The design of the apparatus to create high temperatures is of particular interest. Further research in this field is aimed at the development of plasma generators without electrodes, very refractory materials, improvement of the cooling system, and new analytical methods. The advantages and limitations of the spraying method, used to produce hard, metallic surfaces widely used in industry, are discussed. (TTT)

13462 RELATIVISTIC SCALAR PLASMA. Hakim, Remi (Temple Univ., Philadelphia). Phys. Rev., 166: 75-81(Feb. 5, 1968).

The behavior of the relativistic scalar plasma in the Vlasov approximation is analyzed. Equilibrium properties are discussed (equation of state, Debye–Hückel law, phase transitions). A dispersion relation for the propagation of a small disturbance is derived. Hydrodynamical equations are obtained. A number of ambiguities inherent in the theory are emphasized and discussed. (auth)

13463 THE LECTURE DEMONSTRATIONS WITH PULSED MAGNETIC FIELDS. Baibulatov, F. Kh. (Novosibirsk State Univ., USSR). Usp. Fiz. Nauk, 92: 347-50(June 1967). (In Russian).

If a magnetic field is rapidly created around a body having an electrical conductivity σ, in a small time t the magnetic field to a certain depth of the skin-layer is $l \cong c\,(t/4\pi\sigma)^{0.5}$. As a result of the occurrence of a magnetic field gradient, a magnetic pressure $p_m = -\nabla H^2/8\pi$ will act on the body. This phenomenon is used for the magnetic compression of a plasma (theta pinch). Equipment is described to demonstrate the radial compression of a metallic tube by a pulsed magnetic field. The pulsed field is created by discharging a battery of condensers into a solenoid, inside of which is a duraluminum tube having an outer diameter of 20 mm and a wall thickness of 0.7 to 1 mm. If the skin-layer is less than the wall thickness, the purely external pressure effect dominates and the cylinder collapses under compression with characteristic wrinkling. On decreasing the wall thickness, the field in the tube tends to be retained so that the inner field exceeds the outer field. The net effect is a compression of the tube which is followed by tube bulging. A detailed design description of the equipment is given to carry out the experiments with the pulsed magnetic fields. (TTT)

13464 ANALOGY BETWEEN LINEAR ISOTROPIC PLASMA THEORY AND CLASSICAL ELASTICITY. Unz, H.; Zorski, H. (Univ. of Kansas, Lawrence. Inst. of Basic Technical Problems, Polish Academy of Sciences). Bull. Acad. Pol. Sci., Ser. Sci. Tech., 15: 745-52(1967).

An analogy between the linearized systems of equations describing the transient waves in isotropic warm plasmas and the system of Lamé equations of classical elasticity, determining small motions of an isotropic homogeneous elastic continuum, was made. (M.O.W.)

13465 CHARGE-CARRIER DENSITY IN AN ELECTRON BEAM PLASMA UNDER THE INFLUENCE OF VOLUME AND WALL RECOMBINATIONS. Heisen, A. (Univ., Munich). Z. Angew. Phys., 24: 61-9(Jan. 3, 1968). (In German).

With regard to a stationary electron beam plasma generated by an anomalous glow discharge, maximum plasma densities in dependence of neutral gas pressure and normalized density distributions are evaluated by means of a simple plain and a cylindrical model. Charge carriers are generated by fast cathode fall electrons which have a gaussian density distribution in direction to the walls (cylindrical model). The carriers are destroyed by wall recombination and volume recombination. The volume recombination is taken to rise up once to the square and once linearly to the electron density. It resulted in a rapid beginning of volume recombination with increasing pressure. With increasing contraction of the carrier generation the proportion of volume recombination is displaced from the center. By comparing the calculation with experimental determined density values it is possible to estimate the type of volume recombination and values of recombination coefficients. (auth)

13466 SOME PLASMA EFFECTS IN SEMICONDUCTORS. Ancker-Johnson, Betsy (Boeing Scientific Research Labs., Seattle). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 27-39(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

A review is presented of some selected plasma effects in semiconductors, principally InSb at 77°K. The production of nonequilibrium electron-hole plasmas by electrical injection and impact ionization is described including some instabilities which attend the latter process. Some new results on the pinch effect obtained by diagnosis with a 10.6 μ CW laser are shown. Observations of the manifestation of another instability, namely gigahertz radiation, not requiring an applied magnetic field are presented. A magnetic field is required to produce some instabilities in plasmas, among these are the helical instability. A bistable element resulting from an inherent hysteresis in the threshold conditions of this instability is described. Discontinuous changes in the plasma conductance can be produced by a magnetic field and the relation of this effect to high intensity microwave emission is outlined. Finally, some preliminary results on plasma decay are presented. (auth)

13467 ELECTRIC CONDUCTIVITY OF A PLASMA IN A STRONG MAGNETIC FIELD. Kadomtsev, B. B.; Pogutse, O. P. Zh. Eksp. Teor. Fiz., 53: 2025-33(Dec. 1967). (In Russian).

The anomalous resistance effect in a plasma is considered under the assumption that the electron Larmor frequency exceeds their Langmuir frequency. It is shown that in this case ion-acoustic instability does not result in appreciable change of the conductivity. However if accelerated electrons appear in the plasma they may become isotropic at the expense of instability of the anomalous Doppler effect and thus increase the plasma pressure. Experimentally this effect may be manifest as an anomalous resistance. (auth)

13468 PARAMETRIC BUILD-UP OF PLASMA WAVES IN AN INHOMOGENEOUS PLASMA LOCATED IN A HIGH FREQUENCY ELECTRIC FIELD. Ramazashvili, R. R. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 53: 2168-75(Dec. 1967). (In Russian).

The behavior of an inhomogeneous plasma in a high-frequency field is investigated. It is demonstrated that parametric buildup of electron Langmuir and ion–acoustic waves is possible providing their frequency does not differ significantly from half the frequency of variation of the electric field. Buildup conditions and increments of the plasma waves are found. (auth)

13469 ADIABATIC TRANSFORMATION OF THE ELECTROMAGNETIC WAVE SPECTRUM IN A PLASMA. Stepanov, N. S. (Gorky State Univ., USSR). Zh. Eksp. Teor. Fiz., 53: 2186-93(Dec. 1967). (In Russian).

Propagation of plane quasi-monochromatic electromagnetic waves in a nonstationary magnetoactive plasma is considered. It is assumed that the parameters of the plasma, viz. electron concentration and drift velocity of the electrons and also the external magnetic field strength, are slow functions of time and, generally speaking, of a single space coordinate. Variation of the frequency and wave number, amplitude and energy of the waves is investigated in the geometrical optics approximation. It is shown that these variations may be quite significant. Moreover the ratio of the wave packet energy to the carrier frequency is an adiabatic

invariant. Some concrete examples are considered and a comparison with an isotropic plasma is made. (auth)

13470 THERMODYNAMICS OF A DENSE PLASMA. Krasnikov, Yu. G. Zh. Eksp. Teor. Fiz., 53: 2223-32(Dec. 1967). (In Russian).

The thermodynamic properties of a dense low-temperature plasma are considered on basis of a method in which the Bloch equation and diagram technique are employed for extending Mayer's group integral theory to a quantum system of interacting particles. Divergences inherent in the Coulomb interaction are removed by rearranging the series terms of perturbation theory. The first stage of the rearrangement corresponds to the Gell-Mann–Brueckner procedure and the second to summation of ladder diagrams containing the effective interaction potential. From the physical point of view this approximation corresponds to simultaneously taking into account collective and individual effects in the plasma. The Gibbs free energy of the plasma is calculated for Boltzmann statistics by the method proposed. (auth)

13471 DIFFUSION AND MOBILITY OF IONS IN A GAS. Smirnov, B. M. Usp. Fiz. Nauk, 92: 75-103(May 1967). (In Russian).

The following subjects are discussed in this review: (1) experimental methods of measuring ion mobility; (2) mobility of ions in a foreign gas; (3) mobility of ions in their own gas; (4) mobility of molecular and complex ions in gas; and (5) formation of ions in molecular gases. The theoretical sections are based essentially on solutions of the kinetic equations in various approximations. The experimental parts are based for the most part on data obtained for alkali-metal ions in inert gases. (ATD)

13472 INITIAL-VALUE PROBLEM FOR RELATIVISTIC PLASMA OSCILLATIONS. Lerche, Ian (Univ. of Chicago). J. Math. Phys. (N. Y.), 8: 1838-47(Sept. 1967).

The solution of the collisionless, relativistic Vlasov–Maxwell set of equations is given for the case where neither ambient electric nor magnetic fields are present and a smeared-out negative charge background preserves overall space-charge neutrality with a relativistic proton plasma. The method of solution is based upon the eigenfunction expansion method invented by van Kampen. It is shown that, besides the relativistically modified modes of Case and Zelazny, there exists a new discrete set of modes whose phase velocities are greater than the speed of light in vacuo. The solution also exhibits the coupling of electrostatic and electromagnetic modes and the existence of complex phase velocities. This initial-value problem (or the problem with the electron and proton roles reversed) is of interest because of the existence of cosmic rays, relativistic electrons emitting synchrotron radiation in nonthermal radio sources, solar noise generation, where electron velocities may approach c (Bailey, 1951), and high-energy electrons in laboratory machines (Post, 1960). In these cases the nonrelativistic treatment is clearly inadequate. (auth)

13473 INTERACTION BETWEEN LONGITUDINAL AND TRANSVERSE PLASMA WAVES. Krishan, Som; Selim, A. A. (Univ. of Alberta, Edmonton). Can J. Phys., 46: 39-42(Jan. 1968).

The rate at which energy is fed into the transverse waves due to interaction with longitudinal waves was calculated for the case of an infinite, homogeneous, isotropic, collisionless plasma. The method is based on constructing the Hamiltonian for the system in terms of creation and annihilation operators of second quantization. From the Hamiltonian, the dominate mechanism was the one in which two longitudinal waves collide to yield one transverse wave. Thus, in general, the energy transfer rate decreases with time. In a special case the results agree with the previous work (Aamodt and Drummond 1964). (auth)

13474 EXCITATION OF THE LONGITUDINAL WAVES IN A BOUNDED PLASMA AT DIFFUSE REFLECTION OF ELECTRONS FROM THE SURFACE. Genchev, Zh. D.; Kalmykova, S. S. (Kharkov State Univ.). Ukr. Fiz. Zh., 12: 1849-53(Nov. 1967). (In Russian).

The problem is investigated on the penetration of an external periodic field with the frequency ω through an isotropic electron plasma layer with the thickness a. The expression for the field is obtained from the solution of the integral equation with a difference kernel. The formulas obtained are compared with the corresponding results for the problem on a semi-infinitely extended plasma. (auth)

13475 PROPERTIES OF THE PLASMA SKIN-SLAB IN MICROWAVE GAS DISCHARGE. Motornenko, A. P.; Belousov, E. V.; Zin'ko, N. S. (Inst. of Radiophysics and Electronics, Kharkov). Ukr. Fiz. Zh., 12: 1815-20(Nov. 1967). (In Russian).

Properties are investigated of a gas discharge made by a strong microwave field which are connected with the appearance of a skin slab unpenetrating for the excitation frequency. It is shown that the excitation of a gas discharge by superhigh frequencies is characterized by the plasma slab formation with a "standard" electron concentration for the given excitation frequency which somewhat exceeds the concentration corresponding to plasma resonance. Variation of gas pressure and microwave power within rather wide ranges does not lead to an essential change in electron concentration of the plasma skin slab. (auth)

13476 HIGH-FREQUENCY ABSORPTION DUE TO ELECTRONS AND PLASMA IN A MAGNETIC FIELD. Procopiu, S.; Viscrian, I. (Physical Research Center, Iasi). Stud. Cercet. Fiz., 19: 711-16(1967). (In Rumanian).

Absorption phenomena occurring in a discharge tube with an incandescent tungsten filament, evacuated to a pressure of 5×10^{-6} torr, were studied. The electrons emitted by the heated cathode were accelerated in a longitudinal magnetic and transversal electric field. It was found that in addition to the electron cyclotron resonance, another type of absorption appears at high currents and at pressures between 10^{-2} and 10^{-3} torr, as a result of the penetration achieved at high frequencies. At pressures below 10^{-5} torr, only the electron cyclotron resonance was noted. The magnetic field, at which the absorption minimum due to penetration appears, depends on the discharge current for a given pressure, and on the relative position of the plasma cylinder. The studies were carried out by choosing a suitable magnetic field intensity and modulating the high-frequency tension; after demodulation, the attenuation signal is observed on the oscillograph. (TTT)

13477 THEORY OF STEADY MOTION OF IONS IN ELECTRIC FIELDS. Hantzsche, E. Beitr. Plasmaphys., 7: 277-92 (1967). (In German).

In a static electric field a one-dimensional model of the motion of ions, controlled solely by charge exchange (electron capture from gas molecules) is considered. Solutions of the kinetic equations for ions and fast neutrals are derived in several special cases. If the charge exchange cross section is constant, the kinetic equation is easily solvable in a closed form; if the cross section is a function of ion energy, however, the problem is reducible to a simple integral equation for the energy distribution function. (auth)

13478 TEMPORAL AND SPATIAL PLASMA WAVE ECHOES. O'Neil, T. M. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Gould, R. W. Phys. Fluids., 11: 134-42 (Jan. 1968).

It is shown that, if a longitudinal wave is excited in a collision-free plasma and Landau-damps away, and later a second wave is excited and also damps away, then a third wave will spontaneously appear in the plasma. This wave appears long after the first two waves have damped away at a time proportional to the interval between the first two waves, and is in that sense an echo. It is also shown that, if a wave is continuously excited at one point in a plasma and a second wave is continuously excited many Landau damping lengths from the first point, then a third wave will spontaneously appear many Landau damping lengths from the second point. Fundamentally, plasma wave echoes are possible because of the reversible nature of Landau damping. However, small-angle Coulomb collisions are very effective in destroying the echo. (auth)

13479 FAST RANDOMIZATION OF AN ELECTRON GAS BY TRAPPED ELECTROACOUSTIC WAVES. Kettani, M. Ali; Hoyaux, Max F. (Carnegie Inst. of Tech., Pittsburgh). Phys. Fluids., 11: 143-51(Jan. 1968).

A simplified theoretical model for a phenomenon of fast randomization of an electron gas which was investigated experimentally is presented. It is assumed that a certain region in constricted electrical discharges, called "plasma sac" can become the siege of trapped electroacoustic waves generated by a beam–plasma interaction. The interaction between those waves and the electron gas is treated by a pseudo-collisional method leading to a generalization of Boltzmann's H-theorem. The velocity distribution, which is essentially Maxwellian with a significant deficiency in the fast electron tail, is deduced. (auth)

13480 ION WAVES IN A COLLISIONLESS PLASMA. Weitzner, H. (New York Univ., N. Y.); Dobrott, D. Phys. Fluids, 11: 152-7(Jan. 1968).

Longitudinal plane wave oscillations of electrons and ions described by the linearized Vlasov equation with no magnetic fields and coupled by Poisson's equation are examined for a wider class of distribution functions than previously analyzed. An expression is obtained for the time evolution of the electric field in terms of approximate wave contributions and a remainder. It is found that

an electron plasma oscillation and an ion wave—either an ion acoustic wave or an ion plasma oscillation—are observable. For a short initial time interval coherent plasma oscillations are observable and persist if the ratio of Debye length to wavelength is small. For larger times, but not too large, ion waves are observable, and they persist for many periods if $\rho^{-1} = \{(T_+/T_-)[(k\lambda_-)^2 + \gamma_0]\}^{\frac{1}{2}} \ll 1$, where γ_0 is a positive constant of order unity determined by the electron distribution functions. The ion waves are thereafter exponentially damped into the incoherent background of the remaining contribution. (auth)

13481 EXPERIMENTAL INVESTIGATION OF AXIAL PLASMA INJECTION INTO A MAGNETIC DIPOLE FIELD. Jensen, V. O. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 11: 240-5(Jan. 1968).

A high-density helium plasma, accelerated from a conical pinch, is injected axially into a magnetic dipole field. Magnetic probe measurements show that, near the axis, a compression of the field is superimposed on the standard diamagnetic depression. The compression starts downstream and moves towards the injector. Simultaneously with the compression, an increase in the electron temperature and reflection of a small amount of plasma are seen. The amount of plasma transmitted through the dipole field is found to be nearly independent of the field strength. (auth)

13482 RADIATIVE MODES OF OSCILLATIONS IN A MAGNETOPLASMA SLAB. Suh, Kiu S. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Phys. Fluids., 11: 185-93 (Jan. 1968).

The radiative modes of electromagnetic wave oscillations in a cold magnetoplasma slab are investigated. The dispersion relations are examined analytically by resorting to various specific cases where simple solutions are obtainable. Numerical solutions are also obtained for the transverse magnetic mode of oscillations where the dispersion relation has a tractable form. For several other cases, the dispersion relation is reduced to forms that are identifiable to the transverse magnetic mode case. Numerous radiative modes that yield large radiative effects are shown to exist. (auth)

13483 NONLINEAR OSCILLATIONS IN A VLASOV–MAXWELL PLASMA. Davidson, R. C. (Univ. of California, Berkeley). Phys. Fluids, 11: 194-204(Jan. 1968).

In the absence of spatial variations, the Vlasov–Maxwell equations are solved exactly allowing for an initial plasma current to generate large-amplitude, oscillatory, electric fields in the presence of a uniform external magnetic field. These results are extended to include the effects of weak spatial inhomogeneities for the case in which no external magnetic field is present. The analysis is carried out to first order in the small parameter, λ ~(Debye length/length scale of spatial variations), by means of a multiple-time, multiple-space, perturbation scheme. Due to the presence of weak spatial variations, a magnetic field is generated oscillating at the plasma frequency, whereas the zero-order electric field is modified by oscillatory behavior at the second harmonic of the plasma frequency. The distribution function is obtained to order λ in situations where the zero-order electric field is initially curl free; under these circumstances no first-order magnetic field is generated and the problem remains electrostatic to order λ. In addition, a nonlinear differential equation is derived describing the long time ($t \sim 1/\lambda$) behavior of the zero-order distribution function; the linear stability of this equation is discussed. (auth)

13484 TWO-POLE APPROXIMATION FOR THE PLASMA DISPERSION FUNCTION. Fried, Burton D. (Univ. of California, Los Angeles. TRW Systems, Redondo Beach, Calif.); Hedrick, C. L.; McCune, James. Phys. Fluids., 11: 249-52(Jan. 1968).

A simple algebraic approximation to the Hilbert transform of the Gaussian, valid over most of the complex plane, is given. (auth)

13485 PROPAGATION OF ION WAVES IN A PLASMA FLOW TOWARDS A TRANSONIC POINT. Cavaliere, A.; Engelmann, F.; Sestero, A. (EURATOM-CNEN, Rome). Phys. Fluids, 11: 158-66(Jan. 1968).

The propagation of ion–acoustic waves in a weakly ionized, bounded plasma is investigated, typically with reference to discharge tubes, where a flow of plasma towards the walls is required to ensure the balance between volume ionization and surface recombination. A macroscopic description is used which accounts for effects of ion–neutral collisions and finite ion temperature. Special attention is paid to the problem of the wave absorption at the plasma boundary. It results that the ion–acoustic waves are strongly absorbed at the plasma boundary whenever the electrostatic boundary conditions require the formation of a space-charge sheath near the walls (implying the existence of a transonic point of the plasma flow at the limit between the sheath and the plasma). The situation where no transonic point exists is also discussed. (auth)

13486 EFFECTS OF ELECTRON-TEMPERATURE VARIATION ON ION ACOUSTIC WAVES. Alexeff, I. (Oak Ridge National Lab., Tenn.); Jones, W. D.; Montgomery, D. Phys. Fluids, 11: 167-73(Jan. 1968).

It has recently been discovered how to vary the electron temperature in a simple discharge-tube plasma over large ranges in a controlled manner. Subsequent use of this technique to study the propagation characteristics of ion–acoustic waves in the plasma, as a function of electron temperature, has made it possible to measure properties of both the waves and the plasma: (1) the theoretically predicted dependence of wave velocity on electron temperature has been verified; (2) good agreement was found between a strong damping of the waves occurring at low electron temperatures and a theoretically predicted Landau damping; and (3) an accurate means for measuring the plasma ion temperature has been found. (auth)

13487 COLLISIONLESS HEATING AND WAVE AMPLIFICATION THROUGH INTERACTION WITH A DENSITY GRADIENT. Lindman, E. L. (Univ. of Texas, Austin). Phys. Fluids, 11: 174-7(Jan. 1968).

Collisionless heating occurs when a magnetoacoustic wave travels at right angles to a magnetic field in a plasma whose density is increasing in the direction of travel. Inclusion of pressure terms in a fluid description leads to an interaction of the wave with the density gradient which allows a net transfer of energy from the wave to the plasma. The mechanism is, however, reversible. Consequently a wave traveling out of the plasma is amplified, and the plasma loses energy to it. A method for obtaining a net transfer of energy to the plasma from a wave originating externally by varying the magnetic field strength is discussed along with the effect of the density gradient on other heating mechanisms. (auth)

13488 INTERACTION BETWEEN AN ELECTROMAGNETIC WAVE, PLASMA WAVES, AND AN ION ACOUSTIC WAVE. Sugihara, Ryo (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.). Phys. Fluids, 11: 178-84(Jan. 1968).

A nonlinear process is considered where a tranverse wave with a frequency near the plasma frequency decays into a plasma oscillation and an ion acoustic wave. The inverse processes are investigated. Also, the interaction of four waves—one tranverse, one ion–acoustic, and two plasma oscillations are investigated. The energy of the tranverse wave is partially converted to that of the ion–acoustic wave in the presence of a plasma oscillation in both cases. A necessary condition for the process of four wave interaction is obtained. The phases of all interacting waves are assumed to be perfectly matched. (auth)

13489 EXCITATION OF LONGITUDINAL WAVES NEAR ELECTRON–CYCLOTRON HARMONICS. Gruber, S. (Sperry Rand Research Center, Sudbury, Mass.); Bekefi, G. Phys. Fluids., 11: 122-33(Jan. 1968).

Longitudinal waves were excited radially across a plasma column subjected to an axial magnetic field. A strip line placed externally to the column was the source of excitation. The wavelength and propagation direction were measured by a movable antenna immersed in the plasma. The measurements are compared with theory and with observations made with an externally situated receiving antenna. The following conclusions are drawn. (a) Contrary to the commonly accepted notion, the longitudinal waves are propagating rather than standing waves. The propagation is radial towards the axis of the plasma column. Since the waves are backward waves, the energy propagates radially outwards. (b) The internal and external measurements are related to good accuracy through the geometrical optics, "phase quantization" condition, $\int k\,dr \approx 2m\pi$, where k is the propagation constant, r is the radial coordinate, and m is an integer. The left-hand side of the equation is deduced from measurements of k made with the movable antenna immersed in the plasma, and the right-hand side of the equation is obtained from measurements of the signal received by the external antenna. (auth)

13490 NONLINEAR INTERACTION OF ELECTROMAGNETIC WAVES IN PLASMA WITH CONSTANT MAGNETIC FIELD. Sauer, K. Beitr. Plasmaphys., 7: 303-20(1967). (In German).

The nonlinear interaction of waves in anisotropic plasmas is considered. Solving the hydrodynamics equations with a n-th order perturbation procedure, an equation for the nonlinear electric field is derived. The n-th order current produced by interaction of waves with lower order is represented by means of a nonlinear tensor of conductivity, which is calculated for n = 2. It is shown,

that a mixed plasma wave with combination frequencies is excited as the result of interaction of two transverse (ordinary) waves propagating perpendicular to the magnetic field. (auth)

13491 NONLINEAR INTERACTION OF OSCILLATIONS IN A PLASMA–BEAM SYSTEM. Shashurin, I. P. (Kiev State Univ.). JETP Lett. (USSR) (Engl. Transl.), 6: 245-7(Oct. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 787-90(Oct. 15, 1967).

When an electron beam interacts with a transversely bounded plasma in a magnetic field under conditions when $f_p > f_H$, simultaneous excitation of microwave oscillations in two frequency regions become possible. The interaction of these oscillations is discussed. (M.O.W.)

13492 DRIFT VELOCITIES AND THERMAL FLUX VECTORS IN A SEEDED PLASMA WITH MAGNETIC FIELDS. Hassan, H. A. (North Carolina State Univ., Raleigh). Phys. Fluids., 11: 106-11(Jan. 1968).

Using the thirteen-moment method of Grad, explicit expressions for the drift velocities and thermal flux vectors in a five-component nonequilibrium plasma in the presence of electric and magnetic fields, and pressure, temperature (or concentration) gradients are presented. The results are valid over a wide range of the degree of ionization and in situations where charge neutrality does not hold. When terms of the order of the square root of the ratio of the mass of the electron to the mass of a heavy particle can be ignored, a direct and simple derivation of the generalized Ohm's law in a multicomponent plasma can be obtained. The influence of charge nonneutrality on the electrical conductivity is discussed. (auth)

13493 QUANTUM-MECHANICAL THEORY OF NONLINEAR PLASMA PHENOMENA IN A STRONG MAGNETIC FIELD. Walters, G. M. (Univ. of Tennessee, Knoxville); Harris, E. G. Phys. Fluids., 11: 112-22(Jan. 1968).

A quantum-mechanical description of a cold plasma in a strong magnetic field is developed from the hydrodynamic equations. The plasmon–particle and plasmon–plasmon interaction Hamiltonians are derived and expressed in terms of second quantized operators for plasmons and particles. The quantum-mechanical plasmon growth rate due to stimulated emission is obtained. The classical limit is taken and compared with the growth rate predicted by the linearized Vlasov equations. The possibility of a spacial gradient instability, that of Mikhailovskii and Timofeev, arises and is interpreted in terms of emission and absorption of plasmons by the energetic particles. The plasmon–particle interaction Hamiltonian is used to determined the time development of the particle distribution function. Finally, the plasmon–plasmon coupling is included in the time development of the plasmon distribution. (auth)

13494 NONEQUILIBRIUM STRUCTURE OF HYDROMAGNETIC GAS-IONIZING SHOCK FRONTS IN ARGON. Hoffert, Martin I. (New York Univ., Bronx, N. Y.). Phys. Fluids., 11: 77-88(Jan. 1968).

A theoretical study has been made of the structure of so-called gas-ionizing hydromagnetic shock waves propagating into "cold" argon in the presence of realistic nonequilibrium effects. To satisfy the definition of these waves, it must be postulated that electrons are created solely by thermal ionization within the front. Comparison of the magnitudes of viscous and magnetic Reynolds numbers indicates that if such structures exist, they will consist of a narrow hydrodynamic (viscous) shock, followed by a much larger region of ionization, relaxation and magnetohydrodynamic interaction. For fronts with this architecture, a modified Zeldovich–von Neumann–Döring approximation applies. Moreover, in this approximation it is impossible to construct nontrivial steady-state structures for "fast" gas-ionizing shocks. Solutions are found, however, for "slow" shocks and these are presented for a family of hydromagnetically oblique gas-ionizing fronts at a Mach number of 20 and Alfvén number of $2^{-\frac{1}{2}}$ for parametrically varied values of the upstream electric field. (auth)

13495 INVESTIGATION OF THE POSITIVE COLUMN ABOVE THE CRITICAL FIELD. Sheffield, John (United Kingdom Atomic Energy Authority, Abindgon, Eng.). Phys. Fluids, 11: 222-33(Jan. 1968).

An experimental investigation, which includes detailed spatial correlation measurements, reveals that the helium positive column is dominated up to many times the critical magnetic field by a finite amplitude helical oscillation. The equations describing this situation are solved by introducing into them experimental values for some of the variables. With this technique it is possible to avoid the use of unrealistic boundary conditions. The calculated values of axial wavelength, helical rotational frequency, and the magnitude of the radial flux of ions are in fair agreement with experimental values. The calculated growth rate is essentially zero up to four times the critical field, in agreement with the theory of Holter and Johnson, but increases steadily with further increase in magnetic field. A possible explanation of the latter region is that the previously stable helical oscillation turns into a helical relaxation oscillation. While the results of this investigation are contrary to the requirements of the turbulence theory of Kadomstev, there is a faint indication that the system may become turbulent at very high magnetic fields. (auth)

13496 PROPAGATION OF PULSE-EXCITED IONIC WAVES IN IONIZED RARE GASES. Doucet, H. (Ecole Polytechnique, Paris). J. Phys. (Paris), 28: 973-7(Nov.-Dec. 1967). (In French).

Using a time-of-flight technique, measurements of the adiabatic compression coefficient for electrons have been performed. The results are found to give a fairly constant value. The wave can be directly observed on a biased probe. (auth)

13497 SPECTROSCOPIC STUDY OF ELECTRON–ION RECOMBINATION IN AN ARGON PLASMA. Frost III, Milton Arthur. Houston, Tex., Rice Univ., 1967. 70p.

Thesis.

Recent studies of electron–ion recombination have shown that a model including recombination into highly excited bound levels through electron–electron–ion collisions and transitions between the bound levels through electron–atom collisions, as well as the usual radiative transitions, is in good agreement with experiments. Detailed spectroscopic studies were made of the recombination process in an argon plasma jet in a low-density wind tunnel. Determination of the decay rate was based on measurement of the absolute intensities of the various transitions of the argon atom and calculated excitation cross sections based on the approximation to the classical method of Gryzinski. The effect of the metastable states was considered and was found to account for the principal reactions as well as the afterglow in the jet. Data taken at a position one inch downstream of a sonic orifice gave a recombination rate of approximately 10^{-12} cm^3/sec; at this location the electron temperature was 4380°K and the electron density was 9.3×10^{12} cm^{-3}. It was found that the plasma could be analytically represented very well by considering it to be a "metastable atom" gas whose "ground" level energy is equal to the energy of the metastable level of the ordinary argon atom. The usual equilibrium relations can then be employed if the electron temperature is used as the characteristic temperature. (Disser. Abstr.)

13498 HARMONIC GENERATION RESULTING FROM THE PASSAGE OF AN ELECTROMAGNETIC WAVE THROUGH AN IONIZED GAS SLAB. Vogel, Richard William. Tallahassee, Fla., Florida State Univ., 1967. 143p.

Thesis.

The effect of collisions on harmonic generation in an ionized gas slab through which an electromagnetic wave is passing is considered. The gas is assumed to have the following features: (a) It is electrically neutral. (b) It is composed of electrons, ions, and neutral molecules of the same species. (c) The interaction between particles in the ionized gas can be treated as binary collisions. (d) The degree of ionization is small so that electron electron and electron–ion collisions can be neglected. (e) The electron–neutral molecule collisions are elastic. (f) The neutral molecules have a Maxwellian distribution at some temperature T and zero drift velocity. (g) One neglects any effects due to ions. Electron–neutral particle elastic collisions are assumed to dominate with a collision cross section dependence $\sigma \alpha u^P$ where u is the relative speed between the electron and neutral molecule. An approximate distribution function is assumed which contains five undetermined parameters. Boltzmann's transport equation is used to obtain three kinetic equations; the kinetic equations are coupled to Maxwell's equations and a Fourier solution in time is used. The ionized gas slab is stratified into a series of individually homogeneous stratum and the equations are solved. The electron temperature and electric field profiles are plotted for various P dependencies of the collision cross section. The first harmonic transmitted and third harmonic generated power are calculated and plotted versus input power for several of P. (Disser. Abstr.)

13499 NONLINEAR ASYMPTOTIC ANALYSIS OF THE POSITIVE COLUMN. Friedman, Herbert Warren. Brooklyn, N. Y., Polytechnic Inst. of Brooklyn, 1967. 238p.

Thesis.

The positive column of a slightly ionized gas discharge confined by cold, insulating walls is described by a set of nonlinear continuum equations. Included in this description are the effects of electron and ion inertia, space charge and charged particle–neutral collisions. In the asymptotic limit of small Debye length, the continuum equations separate into two parts, are valid in the

quasi-neutral plasma region and the other valid in the space charge sheath. Using the method of matched asymptotic expansions, a zeroth-order solution is derived which is valid throughout the entire cross section of the positive column. The value of potential at the wall is calculated according to a kinetic model and the effects on this potential of a small amount of wall current and reflectivity are investigated. It is found that the density at the wall can be a significant fraction of the value at the center in the limit of low neutral gas pressure. The boundary condition used in the linear theory, that the density at the wall is zero, is approximately satisfied in the high-gas-pressure limit. However, in this case, the sheath becomes collision-dominated and no analytic solutions are available. The original Bohm criterion is recovered as a necessary condition for a steady-state sheath and is interpreted to mean that the ambipolar sound speed asymptotically separates the plasma from the sheath. A stability analysis of a collisionless plasma confined in a box is examined within the framework of the continuum equations. The results of this analysis are applied to the region of the positive column in the vicinity of the interface separating the plasma and sheath regions and it is concluded that this region is indeed stable. An interesting connection between the electrostatic shielding properties of a general collisionless plasma and the onset of instability is presented. The singularities of the complete two-fluid equations are investigated. It is found that the singularity in the zeroth-order equations indicating a transition from plasma-to-sheath regions disappears in the exact equations and a smooth transition is predicted. Another singularity which is present in the exact equations, but not in the zeroth-order equations, is shown to be removable by imposing a relation on the dependent variables at the singular point. In order that the exact equations be well posed: (1) the boundary conditions are so chosen to ensure that the constraint relation is satisfied and (2) a kinetic model is derived which uniquely specifies the wall potential for a given plasma configuration. The occurrence of a removable singularity is shown to be analogous to the phenomenon of transonic flow in a convergent–divergent nozzle. (Disser. Abstr.)

13500 ENERGY TRANSFER AND ELECTRON CONDUCTION IN THE FLUID TRANSPIRATION ARC COLUMN. Tschang, Pin-Seng. Newark, N. J., Newark Coll. of Engineering, 1967. 240p.

Thesis.

The energy relaxation and electrical conductivity of an electron gas in one atmosphere argon arc discharge has been examined theoretically and observed quantitatively in an experimental arrangement. The plasma column utilized for study is the type generated in a fluid transpiration arc equipment in which the argon working fluid is injected through a porous graphite anode. The rate of forced convection is such as to ensure significant electron–heavy particle nonequilibrium in the sample volume of interest. A simple model of a developing arc column with internal heat generation indicates that, with typical rates of argon injection realized in practice, the development of the column in the axial direction from a constant radial profile to a nearly fully developed profile requires several cm, of which the first cm or so may be characterized as quasi one-dimensional in z. This region is large enough to allow transient probings and spectrometric observations the results of which can then be compared in a straightforward manner with a theoretical one-dimensional model. An examination of the various relaxation times in a three-component fluid (electron–ion–neutral) reveals that the self-relaxation times are not negligible compared with the transit times through the nonequilibrium volume. It is therefore proper to employ the usual two-temperature macroscopic model equations obtained from the Boltzmann equation. Accordingly, the electrical conductivity and the two-temperature volume rates of energy transfer have been obtained. The diagnostic techniques utilized include (1) Hall-effect magnetic field probe for current density, (2) floating electrostatic probe for electric field, (3) spherical thermocouple heat transfer probe for heavy particle temperature, and (4) continuum intensity measurement for electron density and temperature. High-speed motion pictures give qualitative measure of the plasma volume and its reaction to a material probe. The results indicate that while somewhat higher electric conductivities are observed the volume rates of energy transfer show fairly wide discrepancy between theory and experiment. Thus, although electron energy loss is observed to be due to volume transfer to the heavy particles the familiar current density compatibility relation, $J = n_e e\sqrt{3k(T_e - T_i)/m_i}$ appears not to hold. This is ascribed to the possibility that the collision frequency for momentum transfer and the collision frequency for energy transfer may not be the same. In particular, the observed collision frequency for energy transfer between electron and ion appears to be one fifth of that magnitude predicted by current theories. It is suggested that a modified theory is needed for the particular condition of low n_D (the number of electrons within a Debye sphere) for $n_e \approx 2 \times 10^{16}$ cm^{-3} and $T_e \approx 10^{4\circ}$K. (Disser. Abstr.)

13501 RESONANCE STUDIES ON RADIO-FREQUENCY PLASMAS. Ransom, Clarence Jefferson. Austin, Tex., Univ. of Texas, 1967. 78p.

Thesis.

Electromagnetic wave energy absorption by a plasma is important in many fields, for instance in the field of controlled thermonuclear reactions. The energy absorption of a plasma with the oscillating electric field perpendicular to the static magnetic field is studied, with special attention given to the lower hybrid resonance. This resonance has been predicted theoretically and is shown to have been found experimentally. Phenomenological results of areas such as anomalous diffusion and controlled helical structures which arise in the investigation are included. (Disser. Abstr.)

13502 LECTURES IN THEORETICAL PHYSICS. VOLUME IX C. KINETIC THEORY. Brittin, Wesley E. (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1967. 801p. $19.50 Hardbound, $8.95. Paperback.

Kinetic theory lectures presented at the Ninth Annual Institute for Theoretical Physics (1966) are included. The topics covered are: (1) kinetic theory of gases fifty years ago, (2) foundations of classical kinetic theory, (3) plasma kinetic theory in the Klimontovich formalism, (4) kinetic theory of inhomogeneous plasmas, (5) Boulder lectures on kinetic theory, (6) Boltzmann equation approach to transport phenomena, (7) turbulence by electrostatic fluctuations, (8) kinetic theory of dense gases, (9) triple collision contribution to the transport coefficients of gases, (10) theory of the hydrodynamical state for dense gases, (11) transport coefficients from time correlation functions, (12) the binary collision expansion method in kinetic theory, (13) nonequilibrium quantum statistical mechanics of plasmas and radiation, (14) plasma transport theory, (15) use of Bethe–Salpeter equation in transport theory, (16) density expansion of quantum mechanical transport coefficients, (17) a correction to the Kubo formula, (18) resonance absorption in many-particle systems, (19) path integral methods in statistical mechanics, and (20) functional methods in the statistical mechanics of fields. (M.O.W.)

13503 PLASMA TURBULENCE EXPERIMENTS. Kellam, John Miles Jr. Baltimore, Johns Hopkins Univ., 1967. 266p.

Thesis.

A series of arc-driven shock tubes were constructed and tested for suitability as a source of plasma for an exploratory investigation of some properties of plasma turbulence. The last of these, designated as segmented tube II, was used for a series of measurements of the effect of a helium plasma on the fluctuation spectrum of an externally imposed magnetic field. Fields of 0, 355, 755, and 1970 gauss were used. A few tests also were made at 3,040 gauss. The calculated magnetic Reynolds numbers were in the approximate range from 1 to 2, based on results obtained with a conductivity probe. A statistical method using ensemble averaging was used to obtain the fluctuation spectra, which were found to follow a power law over a frequency range from approximately 0.2 to 1 MHz. The exponents varied from $-1\frac{1}{2}$ to $-1\frac{2}{3}$. The spectra without external magnetic field tended to have the lower (in absolute value) exponents, but those for external fields of 1970 gauss were also usually somewhat lower than those at intermediate magnetic field strengths. A strong externally imposed magnetic field (of the order of 1500 gauss or more) was found to tend to suppress fluctuations in the magnetic probe signals and also to slow down the plasma passing through it, particularly at the lower pressures. The time averages of the standard deviations of the component of magnetic probe wave form fluctuations parallel to the externally imposed magnetic field were larger than those of the other two components. This time average increased approximately linearly with increasing field up to a maximum at a field of about 1150 gauss, above which it decreased again with further increases in magnetic induction. The other two directional components were more nearly equal in magnitude and were somewhat less sensitive to the intensity of the external magnetic field. Since the estimated Reynolds number was rather low for turbulence in the usual sense to be expected, the fluctuations may have been due largely to hotter (and more conductive) portions of the plasma dragging a fraction of the external magnetic field with them past the magnetic probe. Results from these experiments tend to support the proposition that the luminous front and plasma following it were primarily gas ejected from the discharge section, rather than shock heated gas. On the basis of conductivity-probe waveforms it is concluded that for this shock tube there was a substantial electrical conductivity in the gas preceding the luminous front. Since the conductivity seemed to be suppressed by a strong external magnetic field, it is postulated that an important feature of the precursors causing the preliminary conductivity was the rather rapid motion of charged particles, such as electrons. (Disser. Abstr.)

13504 NONEQUILIBRIUM STRUCTURE OF HYDROMAGNETIC GAS-IONIZING SHOCK FRONTS IN ARGON. Hoffert, Martin Irving. Brooklyn, N. Y., Polytechnic Inst. of Brooklyn, 1967. 65p.

Thesis.

An analytical study of the structure of gas-ionizing hydromagnetic shock waves was made. Since these waves, by definition, must have nonelectrically conducting upstream states, their existence at very high shock temperatures must be ruled out on the physical grounds that forward-radiated precursor ionization makes the unshocked gas conducting. A "low-temperature" collisionally ionizing shock with oblique magnetic field is studied here to determine whether certain concepts which exist in the current literature are relevant. Nondimensionalized equations governing the nonequilibrium structure of such a front propagating into un-ionized argon are formulated using ionization rates and an electron energy equation developed in an earlier paper. Comparison of the magnitudes of viscous and magnetic Reynolds numbers within this front indicates that, if a structure exists, it must consist of a narrow "imbedded" viscous shock standing upstream of a much wider hydromagnetic interaction and ionization relaxation zone. Hence, a modified form of the Zeldovich–von Neumann–Döring (ZND) approximation is applicable to the structure problem. It is shown that in this approximation nontrivial steady-state structures cannot be constructed for "fast" gas-ionizing shocks. On the other hand, solutions are possible for "slow" waves, and these are obtained numerically for a family of hydromagnetically oblique shocks at Mach number $M_1 = 20$ and Alfvén number $M_{A_1} = 1/\sqrt{2}$ with parametrically varied values of the upstream electric field. In contrast to previous expectations, the upstream electric field is not uniquely defined by the structure. Because the slow solutions are effectively exothermic, to the point where their post-shock temperatures are associated with radiation-induced precursor ionization, it seems likely that only the solution with the upstream electric field corresponding to a pure hydromagnetic shock has physical significance. (Disser. Abstr.)

13505 RADIATION AND SCATTERING PROBLEMS IN COMPRESSIBLE PLASMAS. Labianca, Frank Michael. Brooklyn, N. Y., Polytechnic Inst. of Brooklyn, 1967. 184p.

Thesis.

Ray-optical concepts are introduced for propagation of electromagnetic and electroacoustic waves in an unbounded compressible plasma, and are then applied to the analysis of radiation in the presence of plane or curved interfaces and obstacles. The method involves tracing of the electromagnetic and acoustic rays through the medium, due account being taken of coupling in source regions, at boundaries, and at scattering centers. The formulas for the reflected, refracted and diffracted fields derived by the ray-optical procedures are then verified by considering different two-dimensional geometries involving bounded, homogeneous, isotropic, compressible plasma regions and performing an asymptotic analysis of the exact integral representations which are developed for the electromagnetic and dynamical fields due to various excitations. The agreement between the results derived by the two methods lends substance to the validity of the ray-optical procedure and suggests its utility for even more general configurations which are not readily subjected to rigorous analysis. Diffraction effects in the form of edge scattered fields, lateral waves on plane boundaries and creeping waves on circular cylinders have also been studied and the field expressions have been cast into ray-optical form. The amplitude dependence in the latter two types of effects can be derived only by exact analysis. In the case of the lateral waves the ray trajectory can be predicted through the use of refractive index diagrams. (Disser. Abstr.)

Production of Plasma

Refer also to abstract 13441.

13506 (NYO-3578-8) PRODUCTION OF PLASMAS FOR THERMONUCLEAR RESEARCH BY LASER BEAM IRRADIATION OF SOLID PARTICLES. Semiannual Report, August 1, 1967–January 31, 1968. Haught, Alan F.; Polk, Donald H.; Fader, Walter J. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Contract AT(30-1)-3578. 22p. (UARL-F-920365-8). Dep. CFSTI.

The Research Laboratories of United Aircraft Corporation are conducting under the subject contract an experimental and theoretical investigation of the production of high-temperature, high-density, spherically expanding free plasmas and the interaction of these plasmas with magnetic containment fields of mirror, cusp, and minimum-B geometry. The plasmas in these experiments are produced by focused laser beam irradiation of a single micron-sized solid particle of lithium hydride which is electrically suspended in vacuum at the focus of a lens. Using this technique, free-expansion plasmas have been produced which measurements show to be essentially spherically symmetric, with a total ion charge corresponding to at least single ionization of all the atoms present in the initial solid particle, and with an average plasma energy in excess of 200 eV. Theoretical studies, using both detailed hydrodynamic calculations and a simplified integrated similarity model, of the free plasma formation and development, have been carried out. The plasma energies calculated with both models are in good agreement with the experimental measurements. The integrated similarity model has been used for calculation of the plasma energy over a wide range of the experimental parameters (particle size, focal spot size, laser power, and laser pulse duration) to determine the optimum conditions for maximum plasma energy. Theoretical studies of the early plasma-magnetic field interaction show that the initial plasma formation and development is unaffected by the presence of magnetic fields of ≤ 10 kG field intensity. As a result, the plasmas generated in the plasma-magnetic field interaction investigations are identical with those studied in the free-expansion experiments. Experimental studies of the interaction of these initially spherical, expanding plasmas with magnetic confinement fields of mirror and minimum-B geometry at field strengths up to 8 kG show that the plasma is contained at densities $\geq 10^{13}$ cm^3 for as long as 10 μsec (minimum-B), and that the major plasma loss is through the mirror loss cones. From measurements of the ion energy of the plasma escaping at late times, the trapped plasma in these experiments is the thermalized laser-produced plasma. (auth)

13507 INFLUENCE OF A CYLINDRICALLY CONVERGING SHOCK WAVE ON A SPARK PLASMA. Hess, Helmut (Humboldt-Univ., Berlin). Beitr. Plasmaphys., 7: 259-76(1967). (In German).

The shock wave is produced by a spark discharge in the axis of a cylindrical vessel. After the reflection at the wall the shock wave returns to the spark channel. The results of time resolved spectroscopic studies of the plasma state are compared with calculations on the basis of a gasdynamic model. The influences of possible deviations from thermodynamic equilibrium are critically discussed. (auth)

13508 LASER SPARK IN A STRONG MAGNETIC FIELD. Vardzigulova, L. E.; Kaitmazov, S. D.; Prokhorov, A. M. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 253-5(Oct. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 799-801(Oct. 15, 1967).

The integral radiation of a laser spark, and also the intensity of laser emission passing through the spark and the threshold of spark production were investigated. The magnetic field reached values of 210 kOe. (M.O.W.)

13509 EXPANSION OF A RESISTIVE PLASMOID IN A MAGNETIC FIELD. Bhadra, D. K. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 11: 234-9 (Jan. 1968).

Calculations are presented which show the effect of resistivity in the expansion of a laser-produced hot plasma against a magnetic field. Without resistivity, the expanding plasma has periodic behavior due to bouncing back from the field; but with resistivity, there is superimposed a slow diffusion (across the field) on the periodic oscillations. This is illustrated by considering a spherically symmetric plasma produced by a giant laser pulse (delivering power of the order of 10^{16}W) illuminating a particle of dimension 10^{-2} cm and subsequently following the time development of its radius, skin-depth, and temperature by integrating the nonlinear equations of motion and Ohm's law. (auth)

13510 PRECURSOR IONIZATION FROM EXPLODING WIRES. Jones, Donald L. (Inst. for Telecommunications Science and Aeronomy, Boulder, Colo.). Phys. Fluids., 11: 247-9(Jan. 1968).

The precursor ionization in an exploding wire discharge is of the order of 10^{12} electrons cm^{-3}. The quantity of ionization produced is a sensitive function of the gas type, distance from the wire axis, pressure, and capacitor energy. (auth)

13511 EXPANSION AND DIFFUSION OF AN ISOLATED PLASMA COLUMN. Hyman, Julius Jr. Los Angeles, Univ. of California, 1967. 101p.

Thesis.

A new plasma source is described in which a collimated beam of high-energy photons generates a plasma in argon by the single-quantum photoionization of the rarefied gas. The photons were generated over a period of 5 μsec by a vacuum spark driven by a 6-μF capacitor charged to 5 kV. The discharge plasma formed by the spark itself was dissipated by interaction with neutral gas

particles and with the beam forming aperture plates before reaching the region in which the photoionization plasma was observed. At 47 cm from the photon source, the density of plasma generation increased from 1.65×10^{11} to 8.22×10^{11} cm^{-3}, as the argon pressure was increased from 2.5 to 15 μ, maintaining a nearly constant fractional ionization of 0.16%. Langmuir probe measurements provided a space and time resolved record of the plasma density, plasma potential, and electron temperature. The radial boundary of the plasma column was well defined at 5 μsec and expanded subsequently at a rate described initially to within 20% by a wave velocity $u = \sqrt{\gamma kT_e/M_i}$. This velocity varies with the square root of the electron temperature, which fell continuously from a value T_e = 0.8 eV at 5 μsec to a value near room temperature at 80 μsec. Initially the electrons were cooled predominantly by adiabatic expansion. After a few ion–neutral collision times (more quickly the higher the pressure) the expansion velocity decreased from the wave velocity given above. In an associated experiment, the plasma was formed in the presence of a uniform, axial magnetic field of intensity B, variable from zero to 3,000 G. For fields in excess of 400 G, the spark-discharge plasma was transmitted along field lines to the region in which the photoionization plasma was observed. This transmission was eliminated for all axial field intensities by imposing a localized 2,500 G magnetic field perpendicular to the photon beam immediately beyond the photon source. In the magnetic field, adiabatic expansion ceased to be a factor in electron cooling. The electron temperature remained at a maximum value of $T_e \simeq 1.5$ eV for over 25 μsec before decreasing due to collisional energy loss. By measuring the initial rate of plasma density decay on the axis, the value of the cross-field diffusion coefficient was determined as a function of magnetic field intensity. The coefficient decreased with increasing field intensity. The experimental measurements are far better described by both the magnitude and the 1/B field dependence of Bohm diffusion than they are by the characteristics of collisional diffusion. Plasma density fluctuations at a frequency ≃20 kHz were observed in the magnetic field. (Disser. Abstr.)

Stability of Plasma

13512 (LA–3778) HYDROMAGNETIC EQUILIBRIUM OF A THIN-SKIN, FINITE-BETA TOROIDAL PLASMA COLUMN. Johnson, J. L.; Morse, R. L.; Riesenfeld, W. B. (Los Alamos Scientific Lab., N. Mex.). Sept. 11, 1967. Contract W-7405-eng-36. 18p. Dep. CFSTI.

An analytic approach to describing the toroidal equilibrium of a finite-beta plasma column in the hydromagnetic approximation is presented. The thickness of the sheath region separating the plasma from the confining magnetic field is assumed to be negligibly small compared to all other dimensions (the "thin-skin" approximation). The deviations of this sharp interface from a toroidal cylinder shape are treated by perturbation theory, a procedure which is shown to be consistent with the usual series expansion in powers of reciprocal aspect ratio. This analytic formulation has the merit of providing engineering design estimates for the auxiliary external current strengths required in a toroidal theta-pinch device (Scyllac) to compensate for toroidal drifts and provide an equilibrium configuration for a finite-beta plasma. The auxiliary fields are superpositions of azimuthally modulated multipole fields applied in addition to an azimuthal modulation component of the main toroidally directed theta-pinch field. It is shown that the presence of this latter component is necessary for a convergent superposition. (auth)

13513 (MPI-PAE/PL–4/67) KINETIC EQUATIONS FOR MICROSCOPIC PLASMA TURBULENCE. Pfirsch, D.; Elsaesser, K.; Biskamp, D. (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). Oct. 1967. 34p. Dep.

Two types of kinetic equations for the homogeneous microscopic turbulence of a one dimensional plasma are compared with each other. These are the usual quasilinear approach and a theory based on the Hamilton–Jacobi formalism. Both theories should yield the same results as long as particle trapping can be neglected. It is estimated that this becomes important for times of the order of $T = 1/\omega_p \times m^2 v_p (\Delta v_p)^3/e^2\phi^2$; here v_p is a typical phase velocity in a reference system with vanishing group velocity, and Δv_p is the range of phase velocities for the unstable modes. For times small compared to T the two theories agree, whereas for times of the order of T the Hamilton–Jacobi approach deviates from the quasi-linear theory in a way which can be interpreted as a relaxation effect. (auth)

13514 (ORO–3405–17) INVESTIGATIONS OF UNIVERSAL PLASMA INSTABILITIES. Quarterly Report No. 7, June 1–August 31, 1967. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Contract AT(40-1)-3405. 9p. Dep. CFSTI.

A preliminary investigation was made of the electron bombardment system for the University of Maryland Q device. A summary of the motivation, design considerations, and the results of preliminary tests of this bombardment diode are given. (M.O.W.)

13515 (UCRL–70665) MULTICOMPONENT PLASMA INSTABILITIES. Pearlstein, L. D. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 9, 1968. Contract W-7405-eng-48. 12p. (CONF-671127–2). Dep. CFSTI.

From International Conference on Plasma Confined in Open-Ended Geometry, Gatlinburg, Tenn.

High-frequency stability of multicomponent plasmas is reviewed for two distinct modes. In both cases, the equilibrium consists of a high-temperature anisotropic or "loss-cone" limited plasma superimposed upon a low-temperature background plasma. In one, the stability of flute-like ($k_\parallel = 0$) electrostatic modes is examined. It is found that instability occurs at frequencies characteristic of electron (ion) gyrofrequencies and their harmonics, provided the species gyrofrequency (Ω) is less than the upper (lower) hybrid frequency (ω_{HY}) of the cold plasma. In this case, one finds instability if the fractional density of hot particles exceeds $(\Omega/\omega_{HY})^4$ for a small admixture of the hot plasma. In the opposite limit, instability occurs if the fractional density of cold particles exceeds $(T_C/T_H)^4$. In the second case, the $k_\parallel = 0$ restriction is removed and it is found that the region of instability now includes $\Omega/\omega_{HY} > 1$. It is also found that for this mode the temperature anisotropy is not critical. (auth)

13516 (NP-tr–1604) ION-CYCLOTRON INSTABILITY OF A PLASMA IN AN ADIABATIC TRAP WITH "MINIMUM-B." Baiborodov, U. T.; Ioffe, M. S.; Sobolev, R. I.; Yushmanov, F. F. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated for Culham Lab., Abingdon, Eng., from report IAE-1331. 25p. (CTO-402). Dep. CFSTI. JCL $2.60 fs, $0.95 mf.

The development of the cyclotron instability at plasma densities of $\sim 5 \times 10^9$ cm^{-3}, ion energies of about 1 keV and magnetic fields of 3000 Oe is investigated. The instability takes the form of "bursts" of 30- to 40-μsec duration accompanied by high-frequency oscillations and ejection of plasma to the wall. There may be considerable variations in character between individual "bursts." The amount of ejection to the wall corresponds to the observed density decrease. The plasma flux distribution to the walls indicates a comparable order of magnitude of the losses parallel to and across the magnetic field. The strong longitudinal expansion of the plasma during a burst also indicated scattering of a considerable proportion of the ions into the loss cone. The hf signal has a line structure with dominant first harmonic, corresponding to the ion-cyclotron frequency. From the magnitude of the electric field one can deduce the excitation of long-wave oscillations with $\lambda \approx 30$ cm in the plasma, characterized by a considerable perturbation of the quasi-neutrality of the plasma (several per cent), and by amplitudes of the potential oscillations of the order of a kilovolt. No agreement between the results is evident from a quantitative comparison of the experimental data with the cyclotron instability theory in a homogeneous plasma. (auth)

13517 (NP-tr–1607) ROLE OF THE ION VISCOSITY IN THE DESTABILIZATION OF ACOUSTIC OSCILLATIONS OF A MAGNETIZED PLASMA. Moiseev, S. S. Translated for Culham Lab., Abingdon, Eng., from pp 1-3 of Preprint No. 46. 4p. (CTO–406). Dep. CFSTI. UK. JCL $1.10 fs, $0.80 mf.

A brief theoretical study is described. (M.O.W.)

13518 (UCRL-Trans–10203) ELECTROSTATIC INSTABILITY DUE TO A DENSITY GRADIENT FOR A DISTRIBUTION FUNCTION HAVING A LOSS CONE. Girard, J. P.; Hennion, F. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by J. Bradley for Univ. of California, Lawrence Radiation Lab., Livermore, from Report No. DPh-PFC/SRACP. 34p. Dep. CFSTI. JCL $3.60 fs, $1.22 mf.

An earlier calculation of this type of instability was based on certain simplifying assumptions that remove the ionic terms proportional to the density gradient. The calculation was repeated without making these assumptions, and it was found that there are two ranges of unstable frequencies. The first instability occurs for small Re ω and Im $\omega < \Omega_i$; it can be determined analytically and numerically. The second instability relates to larger values of Re ω, though the rate of buildup appears to be small. (M.O.W.)

13519 THEORY OF UNSTABLE PLASMAS IN THE RING APPROXIMATION. I. Grecos, A. P. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg., 53: 642-62(1967).

A one-component electrostatic plasma without external field is considered. The nondimensional parameter $\tau = e^2 c^4 b$ is assumed to be much smaller than unity. The discussion is restricted to the

case where the dielectric function of the system has only simple zeros. (M.O.W.)

13520 INSTABILITIES: CONVECTIVE VERSUS ABSOLUTE. Hall, Laurence S.; Heckrotte, Warren (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev., 166: 120-8(Feb. 5, 1968). (UCRL-70557).

The response of a medium to a pulse disturbance is determined by the zeros of the dispersion function $D(k,\omega)$ in the complex domain of both the wave number k and the frequency ω, and the asymptotic nature of the response near the origin depends on the velocity V of the frame of reference of the observer. In particular, a crucial feature for an unstable medium is the behavior, as a function of V, of the position of the saddle points of $\bar{\omega}(k) = \omega(k) - kV$, defined by the requirements $D(k,\omega) = 0$, $\partial D/\partial k + V\partial D/\partial\omega = 0$, since $\mathrm{Im}\bar{\omega}$ for suitably defined saddle points gives the asymptotic growth in frame V. Thus, if $d^2\omega/dk^2$ is taken along the contour D = 0, the differential equations for the variation of a saddle point $\delta k/\delta V = (d^2\omega/dk^2)^{-1}$, $\delta\omega/\delta V = V(d^2\omega/dk^2)^{-1}$, $\delta\bar{\omega}/\delta V = -k$ (only two of which are independent) can be used to plot the asymptotic pulse shape. A new phenomenon of general interest to the theory of singularities of a function of two complex variables is described which, in the present context, is associated with the significance or insignificance of a given saddle point in contributing to instability, and with how this significance may change with V. This (mathematical) phenomenon may also be of relevance to elementary-particle theory through its importance to the theory of the analytic structure of scattering amplitudes. The results of the theory are applied to certain examples of plasma physics, obtaining for these cases quantitative descriptions of the asymptotic shape of a pulse disturbance in unstable media. (auth)

13521 HYDROMAGNETIC STABILITY OF A PLASMA IN A QUASI-HOMOGENEOUS MAGNETIC FIELD. Solov'ev, L. S. Zh. Eksp. Teor. Fiz., 53: 2063-9(Dec. 1967). (In Russian).

A condition for hydromagnetic stability is derived for an arbitrary equilibrium plasma configuration confined by a quasi-homogeneous magnetic field. (auth)

13522 CURRENT-CONVECTIVE INSTABILITY OF AN ELECTRON BEAM IN A PLASMA. Raizer, M. D.; Rukhadze, A. A.; Strelkov, P. S. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 53: 1891-1900(Dec. 1967). (In Russian).

The passage of an electron beam through a plasma produced by the beam itself in a uniform magnetic field is investigated. It is shown that under certain conditions two phases of the process in time can be discerned, a stable and an unstable one. Transition to the unstable stage is manifest by a sharp decrease of the current at the collector and is accompanied by an increase of the plasma density and by an intense uhf radiation. The duration of the stable stage was investigated experimentally as a function of the initial gas pressure, electron beam density, system length, and magnetic field strength. The magnetic field is found to exert a stablizing effect. Current-convective instability during interaction between the beam and the electron component of the plasma is calculated. The main experimental dependences are in good agreement with the theoretical results. (auth)

13523 CURRENT-CONVECTIVE AND OVERHEAT INSTABILITY OF PLASMA. Aleksin, V. F.; Polevich, V. V. (Physico-Technical Inst. of Low Temperature, Kharkov). Ukr. Fiz. Zh., 12: 1893-6(Nov. 1967). (In Russian).

Stability of plasma, located in axially symmetrical magnetic fields, is studied on the basis of the equations of magnetohydrodynamics, the dissipating members (electroconductivity and heat conductivity) included. Stability conditions are obtained for the case of both low and high frequencies. The plasma density, temperature, and also the magnetic and electric fields are considered as parameters on which the plasma stability is dependent. (auth)

13524 ENERGY PRINCIPLE FOR PLASMA STABILITY AGAINST LOW-FREQUENCY INTERCHANGES. Rutherford, Paul H.; Frieman, Edward A. (Princeton Univ., N. J.). Phys. Fluids, 11: 252-4(Jan. 1968). (MATT-560).

An energy principle is constructed for the stability of a plasma equilibrium $F \equiv F(\mu, J, K)$ against low-frequency interchanges, including trapped particle instabilities. (auth)

13525 RESISTIVE INSTABILITIES IN A LOW-ENERGY THETA PINCH. Benford, James; Lovberg, R. H.; Niblett, G. B. F. (Univ. of California, San Diego, La Jolla). Phys. Fluids, 11: 218-21(Jan. 1968).

Schlieren and Kerr cell photography is used to study the effect of reversed trapped field on a low-energy theta pinch. At low plasma temperatures the rapid diffusion of magnetic field is observed to inhibit the growth of resistive instabilities of the tearing-mode form, and this result is in accord with theoretical predictions. (auth)

13526 NEGATIVE MASS INSTABILITY WITH B_θ FIELD. Landau, Ronald W. (Physics International, San Leandro, Calif.). Phys. Fluids., 11: 205-17(Jan. 1968).

Earlier negative mass instability calculations with a mirror magnetic field have been extended to also include a B_θ field. The plasma is contained in a torus, of elliptical cross section, which is radially thin. From a new dispersion relation it is found that: (a) for a cold plasma the negative mass instability persists even for large B_θ, although the growth rate goes as B_θ^{-1}; (b) for a finite-velocity-spread plasma, the addition of a B_θ field allows much higher densities, because the stability criterion becomes independent of density. These results appear to explain the beam disruption observed on the Stevens Institute plasma betatron suprisingly well. (auth)

Shielding

Refer also to abstracts 13904 and 13924.

13527 (EUR-2204) GAMMONE: PROGRAMMA MONTE-CARLO PER IL CALCOLO DELL'ATTENUAZIONE DEI RAGGI GAMMA ATTRAVERSO SCHERMI LAMINARI COMPOSITI. PARTE 1a. FONDAMENTI MATEMATICI DEL PROGRAMMA. PARTE 2a. CODIFICAZIONE DEL PROGRAMMA. (GAMMONE: Program for Gamma-Ray Attenuation Through Multilayer Composite Shields. Part 1. Mathematical Bases of the Program. Part 2. Coding of the Program. Criscuolo, L.; Cerisola, M. G. (FIAT, Turin (Italy). Sezione Energia Nucleaire). Jan. 1965. Contract 008-61-12 PNII. 120p. (In Italian). Dep.

The GAMMONE program is an IBM-704 code which applies Monte Carlo methods to simulate gamma-ray life histories in a source-shield configuration. The present report describes the physical and mathematical bases of such a program. The shield studied is a multilayer composite rectangular parallelepiped. The gamma source has different shapes: point, line, infinite plane, disc. Several techniques, such as importance sampling, are used for increasing the efficiency of a Monte Carlo calculation. The outputs of the code are energy and dose attenuation and build-up through the shield, as well as energy and dose reflection probability at the source-shield interface. A comparison of results obtained from the code shows good agreement with results from other authors. The GAMMONE (Gamma Monte Carlo) IBM-704 computer program determines, using sophisticated Monte Carlo techniques, gamma-ray attenuation characteristics in a composite multilayer shield. The present report presents the FORTRAN listing of the main program and of the seven subroutines, a short explanation of the use of such subroutines, some typical outputs, the detailed description of the input formats. (auth)

13528 (ORNL-tr-1856) DETERMINATION OF THE DOSE BUILDUP FACTORS FOR GAMMA RAYS IN THE ENERGY REGION OF 0.5 TO 15 MeV IN LAMINATED SHIELDS OF IRON AND WATER. Vogt, H. G. (Technische Hochschule, Hanover (West Germany). Arbeitsgruppe fuer Bautechnischen Strahlenschutz). Translated for Oak Ridge National Lab., Tenn., from report ABS-THH-1029. 36p. Dep. CFSTI. JCL $3.60 fs, $1.28 mf.

The dose buildup factors were determined for a shield with two layers of iron and water which are to permit a comparison with the results of these calculations. The measuring method is based on differential scattered radiation measurements. The buildup factors here are valid for the case of an infinitely extended, parallel radiation field with a constant flux density which is incident perpendicular to the plane shield. The measurements were made behind 20 shield combinations with different iron and water thicknesses. (M.H.R.)

13529 (ORNL-tr-1857) A METHOD TO DETERMINE THE COMPTON SCATTERING ANGLE FROM ITS CUMULATIVE PROBABILITY IN THE MONTE CARLO CALCULATION. Yamakoshi, Hisao; Nakata, Masaya. Translated for Oak Ridge National Lab., Tenn., from Senpaku Gijutsu Kenkyujo, 2: 311-16(1965). 11p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

A new way to decide the Compton scattering angle from a random number given as its cumulative probability is presented. This way is useful to trace rather higher-energy γ rays in the Monte Carlo method calculation. As an example, four tables necessary for the γ-ray energy range from 5 to 10 MeV are shown. The present example gives the scattering angle with accuracy less than one degree through a one-table lookup step and, at most, five-multiplying and two dividing steps. (auth)

13530 SHIELDING PROPERTIES OF CONCRETE FOR D-T NEUTRONS. Broerse, J. J. (Radiobiological Inst. TNO, Rijswijk, Netherlands). Int. J. Appl. Radiat. Isotop., 19: 74-6 (Jan. 1968).

Reference is made to a paper by Hacke (Internat. J. Appl. Rad.

Isotop. 18: 33 (1967)) on dosimetry and shielding for a 14-MeV neutron generator, in which a relaxation length of 15 cm for concrete is derived, a value smaller than that found by the present author (Health Phys. 12: 83 (1966)). For a concrete thickness of 100 cm, Hacke's results indicate a dose equivalent transmission factor of 8×10^{-4}, whereas measurements by the present author indicate a value of 6×10^{-3}. The discrepancies in the results are discussed. (UK)

13531 DETERMINATION OF EXPOSURE BUILDUP FACTORS FOR GAMMA RADIATION IN THE ENERGY RANGE OF 0.5 TO 15 MeV IN STRATIFIED SHIELDS OF IRON AND WATER. Vogt, H. G. (Technische Hochschule, Hanover). Nucl. Eng. Design, 6: 325-41(1967). (In German).

An experiment was performed for the determination of exposure buildup factors in stratified slabs of iron and water within the energy range from 0.5 to 15 MeV. The arrangement consists of a betatron as the source, the shield specimen, and the detector unit (sodium iodide crystal; multichannel analyzer). A narrow collimated beam penetrates the shield model. The scattered radiation as well as the unscattered radiation transmitted through the slabs are measured separately at the backside of the shield. As the intensity of the scattered radiation decreases exponentially with increasing distance from the central beam the exit area of the effective radiation is relatively small. The scattered radiation is measured at several points with different distances from the axis of the central beam. Integration over the backside of the shield model gives the scattered radiation of an infinite parallel beam and thereby together with the unscattered radiation an adequate buildup factor for the spectrum of the primary radiation. In order to get buildup factors for monoenergetic radiation, the maximum energy of the primary radiation has to be varied within the energy range required. Results are obtained by means of a system of linear equations. The transposition of the measured pulse spectra of the scintillation counter into energy spectra and exposure rates as well as the calculation of the buildup factors for monoenergetic radiation from those for the spectra of the primary radiation is performed by two special computer programs which enable to determine buildup factors for any shield lamination composition with reasonable calculational effort. The results of the measurements behind single layers of water and double layers of iron and water are in good agreement with theoretical calculations. (auth)

13532 INTERNAL RADIATION ENVIRONMENT OF CYLINDRICAL SPACECRAFT. Mack, Charles L. (Massachusetts Inst. of Tech., Lexington). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 204-9(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

A laboratory study of the shielding against energetic electrons afforded by cylindrical aluminum satellites is reported. The incident electron flux had a near-exponential integral energy distribution with a folding energy of 500 keV over the range: 140 keV to 3.0 MeV. The angle of incidence was isotropic in the plane normal to the cylindrical axis and randomly distributed within an envelope of approximately ±55 degrees in the orthogonal plane. The satellite was thus simulated at an erect attitude to the earth's magnetic field in a region of trapped radiation. Internal spectral flux measurements were made on the axis and at the periphery of cylinders having height-to-diameter ratios from 1:4 to 4:1 with wall thicknesses from 180 mg/cm^2 to 900 mg/cm^2 in nominal 25-mil steps. (auth)

Solid-State Physics

Refer also to abstracts 12366, 12580, 12693, 12700, 12722, 12736, 13254, 13292, 13391, 13923, and 14100.

13533 (IS-1734) EXPLICIT FORMULAE FOR THE MAGNETIC INDUCTION IN UNIFORMLY MAGNETIZED ELLIPSOIDS OF REVOLUTION. Schau, Candace A.; Stone, Dennis R. (Ames Lab., Iowa). Dec. 1967. Contract W-7405-eng-82. 13p. Dep. CFSTI.

The Stoner–Wohlfarth theory has been extended to give implicit formulae for the magnitude and direction of the magnetic induction in a single-domain ferromagnetic ellipsoid of revolution. Explicit formulae for the magnetic induction have been suggested by Gold; quantitative comparison shows that these approximate expressions compare quite well with the exact results obtained from the Stoner–Wohlfarth theory. (auth)

13534 (NYO-2471-31) ACOUSTIC ATTENUATION IN KCl AND KCl:Li$^+$ IN THE KILOMEGACYCLE RANGE. Report No. 841. Auyang, Raymond Ping (Cornell Univ., Ithaca, N. Y. Materials Science Center). Jan. 1968. Contract AT(30-1)-2471. 72p. Dep. CFSTI.

Thesis.

The ultrasonic attenuation in KCl and KCl containing Li^+ impurities was measured in the frequency range of 500 to 1745 Mc at temperatures from 1.7 to 30°K. After substracting the low-temperature "background," all the attenuation constants of the pure modes in KCl were found to vary as T^4 except the ⟨111⟩ shear mode and the ⟨110⟩ shear mode with a ⟨110⟩ polarization. For these two shear modes, the temperature variations are slower and not expressible as a single power of the temperature. A linear frequency dependence was observed for all the longitudinal modes in KCl in agreement with the collinear interaction theories of Shiren and Barrett. The absolute values and variations with type of mode agree qualitatively but not quantitatively with the theoretical values. The value for the ⟨100⟩ shear is two orders of magnitude higher than that calculated by Shiren for phonons with infinite lifetime; the agreement between experiment and theory is much better if relaxation of phonons (finite life time) also for the transverse modes is taken into account. The attenuation in KCl containing Li^+ impurities can be divided into two temperature regions. In the high temperature region, above 13°K, the attenuation follows a T^4 temperature dependence as in the pure KCl. In the low temperature region, only the attenuation of sound waves containing a trigonal (T_{2g}) acoustic mode varies with temperature. The attenuation in this temperature region was found to follow a 1/T law and to scale approximately with concentration. The lack of an interaction of the tetragonal acoustic mode with the Li^+ impurities reconfirms Byer's finding in his low frequency acoustic measurements that the potential wells of the off-center Li^+ are along the ⟨111⟩ axes. The attenuation of the trigonal acoustic mode increases monotonically with frequency but less than linearly. The high-frequency and low-frequency points fall on a smooth curve which is interpreted in terms of a frequency variation of the half-width of the tunneling resonance. (auth)

13535 (NYO-3699-21) CALCULATION OF PHONON LIFETIMES IN SOLID ARGON. Jones, Hilary David (Cornell Univ., Ithaca, N. Y.). Feb. 1968. Contract AT(30-1)-3699. 183p. Dep. CFSTI.

Thesis.

The theory is based on a first principles treatment of three phonon interactions in perturbation theory. The usual assumptions of the Debye approximation or of isotropic phonon–phonon interaction strength has not been made. Computer calculations are made. (M.O.W.)

13536 (NYO-3699-22) ATOMIC TUNNELING IN SOLIDS. Krumhansl, J. A. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Jan. 1968. Contract AT(30-1)-3699. 14p. Dep. CFSTI.

The motion of atoms by tunneling between two or more equivalent potential wells in a crystal is discussed. Atomic tunneling is discussed in connection with optical, thermal and inelastic effects, and the symmetry of defects. (M.O.W.)

13537 (ORNL-TM-2054) EMPIRICAL RELATIONSHIPS FOR THE EMISSION ENERGIES AND LIFETIMES OF THE F CENTER. Gilbert, R. L. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 25p. Dep. CFSTI.

Empirical relations for the emission energies, ϵ, and the lifetimes, τ, of the F center in the Na, K, Rb, and Cs halides have been established with the following forms: $\epsilon = AK_0^n$ and $\tau = A'K_0^{n'}$, where K_0 is the optical dielectric constant. The existence of two classes of radiative lifetimes is suggested. Those τ observed at liquid helium temperatures (fluorescence measurements) and those measured above liquid nitrogen temperatures (photoconductivity measurements) yield separate straight lines on log–log plots of τ vs K_0. Implications of the existence of these correlations are discussed. (auth)

13538 (UUIP-543) OPTICAL PROPERTIES OF MINUTE ALKALI METAL PARTICLES. Karlsson, A. Vigner (Uppsala Univ. (Sweden). Inst. of Physics). May 1967. 12p. Dep.

Optical extinction was studied in sodium chloride crystals containing sodium in colloidal form. The influence of cooling time on extinction was determined. The behavior for very small colloidal particles was found to fit theoretical calculations. (Sweden)

13539 (UUIP-550) HIGH-FIELD MOMENTUM DISTRIBUTION FUNCTION OF ELECTRONS IN GaAs. Forssen, Bengt-Herman (Uppsala Univ. (Sweden). Inst. of Physics). June 1967. 6p. Dep.

The electron distribution function in GaAs was studied. An iterative numerical method was used. It is shown that the distribution function is strongly anisotropic in momentum space. (auth) (Sweden)

13540 (UUIP-553) ELECTRON BINDING ENERGIES IN PLATINUM. Karlsson, S.-E.; Norberg, C.-H.; Nilsson, O.; Hogberg, S.; El-Farrash, A. H.; Nordling, C.; Siegbahn, K. (Uppsala Univ. (Sweden). Inst. of Physics). July 1967. 20p. Dep.

The 50-cm iron-free spectrometer at Uppsala was adapted to ESCA studies. The energies of all L, M, and N, and some O atomic levels in platinum were precisely determined using this instrument. No evidence for the recently reported L_{II} binding energy anomaly was found. (auth) (Sweden)

13541 THE DISPLACEMENT OF F^- IONS IN CaF_2 CRYSTALS BY γ IRRADIATION. Kask, N. E.; Kornienko, L. S. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 9: 1670-1(Jan. 1968).

Translated from Fiz. Tverd. Tela, 9: 2127-8(July 1967).

Experimental investigations were made of the shift mechanism of F^- ions resulting from gamma irradiation and subsequent thermal treatment of the CaF_2 crystals. The changes in the local environment of paramagnetic impurity ions were observed by the EPR method. From an earlier work on the effects of gamma radiation on the rhombic spectra of Nd^{3+} and Dy^{3+} impurity ions in CaF_2 crystals grown in the presence of oxygen, it was concluded that vacancies must be filled by F^- ions displaced from a sufficiently distant lattice site. This assumption was confirmed by observations of the Er^{3+} ions in certain crystals also containing Nd^{3+} ions grown in a fluorinating atmosphere, in which only a cubic spectrum was shown. In these crystals, no tetragonal spectrum was observed at 77°K; however, this spectrum was observed at 300°K, or when crystals previously irradiated at 77°K were heated to 300°K. The heating, however, failed to bring out the tetragonal spectrum when the specimens were subjected to sufficiently intense light before heating. In general, the processes leading to a change in the local environment are the same with Nd^{3+}, Dy^{3+}, and Er^{3+} ions and are connected with the displacement of F^- ions. The mechanism involves the generation of an interstitial halide ion on coincidence of two positive holes in neighboring ions of the halide. The self-localization of the holes at 77°K, the suppression of the gamma effect by light, and the restoration of the initial state at temperatures of about 500°K, can all be explained by this mechanism. A formula for the temperature dependence of the spin–lattice relaxation time of the Er^{3+} ions in the cubic field of CaF_2 was also obtained on the basis of experimental data, which, however, differ from results reported by others. (ATD)

13542 SOME NEW PHASES OF COMPOSITION MX_5 OF Eu AND Yb WITH STRUCTURAL TYPE $CaCu_5$. Palenzona, Andrea. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 42: 504-9(Apr. 1967). (In Italian).

The behavior of Eu and Yb with Ni, Cu, Ag, and Au was investigated over the composition MX_5 and some new compounds were found, all with the $CaCu_5$ structure type, namely: $EuNi_5$, $YbNi_5$, $EuCu_5$, $YbCu_5$, $EuAg_5$, $EuAu_5$. Their crystal structure and interatomic distances are briefly discussed together with those of the corresponding (Ca, Sr, Ba)X_5 isomorphous compounds. In most cases Eu and Yb behave as divalent elements while only in MNi_5 compounds do they show evidence for trivalency. (auth)

13543 OPTICAL PHONONS IN BeO CRYSTALS. Loh, Eugene (Douglas Aircraft Co., Santa Monica, Calif.). Phys. Rev., 166: 673-8(Feb. 15, 1968).

The optical phonons of BeO crystals have been studied by measurements of polarized infrared reflection spectra in the range 400 to 4000 cm^{-1}. Raman spectra for shifts in the range 100 to 1500 cm^{-1} at room temperature were analyzed. Oscillator fits to the reflectivity spectra lead to values for the frequency, linewidth, and strength of the A_1 and E_1 vibrations. The infrared data are confirmed by the Raman measurements, which also give the Raman-active-only E_2 vibrations. Within experimental error, the high-frequency E_2 mode at 684 cm^{-1} coincides with the A_1 transverse mode and is at about twice the frequency of the low-frequency E_2 mode. The multiple-phonon absorptions at zone boundaries have also been measured at room temperature on the high-energy side of the reststrahlen band up to 4000 cm^{-1}. (auth)

13544 WIDE RANGE TEMPERATURE CONTROLLER FOR NMR STUDIES. Raymond, R. H. (Shell Development Co., Emeryville, Calif.). Rev. Sci. Instrum., 39: 253(Feb. 1968).

A brief description of the controller is given. (M.O.W.)

13545 LOOKING AT SOLIDS WITH NEUTRONS. Bacon, G. E. (Univ. of Sheffield, Eng.). Proc. Roy. Inst. Gt. Brit., 41: 510-31(1967).

This is a review discourse presented at Royal Institution on March 17th, 1967, on the use of neutron beams for the study of solids. (UK)

13546 TEMPERATURE DEPENDENCE OF GROUP DEFECTS INDUCED IN GERMANIUM BY FAST NEUTRON IRRADIATION. Starostin, K. L.; Tuturov, Yu. F.; Poretskii, L. B. Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1928-30(1967). (In Russian).

Fast-neutron radiation effects on n-Ge properties in the temperature range from 78 to 298°K were investigated. Measurements were made of the Hall effect and conductivity of $1 \times 1 \times 10$ mm^3 specimens of n-Ge with an initial electron concentration of 2.0 to 2.5×10^{15} cm^{-3} irradiated with neutrons close to the fission spectrum. Curves show the radii of disordered regions as a function of temperature of irradiation and the Hall-constant changes during irradiation at 80°K. (R.V.J.)

13547 NEUTRON RADIATION EFFECTS ON THE COERCIVE FORCE IN MOLYBDENUM PERMALLOY. Vasil'ev, B. V. Fiz. Metal. Metalloved., 24: 757-9(Oct. 1967). (In Russian).

The influence of isochronous annealing on the coercive force in molybdenum Permalloy (Ni–Fe alloy) irradiated by neutrons in a nuclear reactor was studied using 30 wires (diam. 0.05 mm and 20 mm long) annealed in hydrogen at 1200°C for 2 hr before exposure. The specimens were irradiated in two reactors with neutron doses of 10^{12} and 8×10^{12} n/cm^2 sec at 30°C. The data obtained showed a maximum increment of coercive force $\Delta H_c^{max} \sim D^{\frac{1}{2}}$ (D is the fast-neutron dose). The H_c appears to be due to small nonmagnetic defects and is proportional to $(\rho/a)^{\frac{1}{2}}a^{\frac{1}{2}}$ (ρ/a is the pore radius expressed in number of interatomic distances). The nonmagnetic impurities are proportional to the fast-neutron dose. (R.V.J.)

13548 MAGNETORESISTANCE OF MOLYBDENUM AND TUNGSTEN (DEVIATION FROM THE KOHLER RULE). Volkenshtein, N. V.; Novoselov, V. A.; Startsev, V. E. (Inst. of Physics and Metals, Moscow). Fiz. Metal. Metalloved., 24: 677-82 (Oct. 1967). (In Russian).

Studies were made of the magnetoresistance of pure Mo and W as a function of the magnetic field strength in various directions at 1.8 to 35°K. A considerable deviation from the Kohler law is explained by specific scattering of conducting electrons at small angles. (tr-auth)

13549 TEMPERATURE DEPENDENCE OF ELECTRIC CONDUCTIVITY OF HYDRIDES OF ZIRCONIUM AND YTTRIUM. Savin, V. I.; Andrievskii, R. A.; Boiko, E. B.; Lyutikov, R. A. Fiz. Metal. Metalloved., 24: 636-40(Oct. 1967). (In Russian).

The electric resistance of stoichiometric yttrium hydride and zirconium hydrides with compositions of $ZrH_{1.69-1.96}$ was measured in the temperature range 1000 to 1200°K. All specimens examined exhibited a characteristic metallic conductivity. The effects of temperature on the electric conductivity and entropy of stoichiometric hydrides were identical to results obtained from calorimetric data. (tr-auth)

13550 NEUTRON DAMAGE IN BERYLLIUM OXIDE IRRADIATED AT HIGH TEMPERATURES. Rau, C. Robert (General Electric Co., Cincinnati). Contract AT(40-1)-2847. Phil. Mag., 16: 663-71(Oct. 1967).

Neutron irradiation of BeO at elevated temperatures produces dislocation loops lying on $\{0001\}$ basal and $\{11\bar{2}0\}$ prism planes. Diffraction contrast experiments in the electron microscope showed that both types of loops are interstitial in nature and of pure edge orientation. The Burgers vector of the basal loops is $c/2\langle 0001\rangle$, and that of the prism loops is $a/3\langle 11\bar{2}0\rangle$. Both types of loops increase in size with increasing neutron dose, but basal loops, which far outnumber prism loops, appear to grow at the expense of the prism loops. High-dose specimens contain tubular hexagonal voids presumably filled with He. (auth) (UK)

13551 SIMULTANEOUS PRODUCTION AND BLEACHING OF F CENTERS IN KCl. Covault, Dennis O.; Pearlstein, Edgar (Univ. of Nebraska, Lincoln). Phys. Rev., 166: 906-1011(Feb. 15, 1968).

KCl crystals are irradiated simultaneously with x rays and light, and then irradiated with x rays in the dark. The resultant F-band coloring is considerably greater than for crystals irradiated the entire time by x rays in the dark. The effect was studied as a function of the wavelength and intensity of the light and the temperature of irradiation. It occurs only for light in the F band. As a function of light intensity, it increases monotonically and then saturates. The amount of light necessary is a strong function of irradiation temperature between 20 and 60°C. The effect did not occur at liquid-nitrogen temperature. Optical and thermal bleaching experiments, for crystals simultaneously irradiated and bleached before coloring, gave different results from those for crystals x-rayed in the dark only. There is some discussion of mechanisms. (auth)

13552 CREATION OF POINT DEFECTS IN ALKALI HALIDES. Royce, B. S. H. (Princeton Univ., N. J.). Progr. Solid State Chem., 4: 213-43(1967).

It is stated that, despite extensive studies in this field, no single model for the creation of lattice defects by ionizing radiation has predominated, although the accumulated data suggest that some models are more probable than others. The present review discusses the following areas associated with the general problem: (i) the ability of the various models to predict the observed defects, (ii) the stability of the anticenter associated with the creation of lattice vacancies, and (iii) the effect of irradiation on back reactions occurring during the defect creation process. Headings are as follows: nature of defects produced by radiation; mechanisms of defect formation; stability of point defects; equilibrium between defect configurations. (84 references) (UK)

13553 GAMMA PHOTOCONDUCTIVITY OF Al_2O_3. Huntley C. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Andrews, J. R. Can. J. Phys., 46: 147-56(Jan. 15, 1968). (AECL-2998).

The electrical conductivity of single-crystal and sintered Al_2O_3 that occurs during bombardment with γ rays has been measured in radiation fields up to 10^6 R/hr, using a ^{60}Co source. The conductivity was different for different crystals and the largest value observed was 0.7×10^{-16} $(\Omega\text{-cm R/hr})^{-1}$; the value for ruby ($Al_2O_3$ + 0.05% Cr_2O_3) was 100 times smaller. The filling of traps by electrons (or holes) manifested itself during the initial radiation of a specimen as a reduced conductivity until the traps were filled; the density and cross section of these traps were $\sim 10^{17}$ per cm^3 and $\sim 10^{-19}$ cm^2, respectively. The shape of the conductivity-vs-time curve during the initial radiation is explained by a model that takes into account the excitation of electrons from traps into the conduction band by the energetic electrons resulting from the gamma radiation. It is shown that this model is able to account quantitatively for the observations, if it is assumed that the time required for a secondary electron to lose energy from 10 to 2 eV is somewhat longer than the time associated with the ionization of a filled trap. Conductivity glow curves were observed in all specimens using internal polarization of the specimens and at least four distinct traps were observed with energies in the range 1 to 2 eV; these are thought to arise from crystal structure defects. (auth) (UK)

13554 EFFECT OF X-RAY IRRADIATION ON PREHARDENED REGIONS OF NaCl SINGLE CRYSTALS. Boyarskaya, Yu. S.; Zhitaru, R. P. (Inst. of Applied Physics, Kishinev, USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 1672-3(Jan. 1968).
Translated from Fiz. Tverd. Tela, 9: 2129-30(July 1967).

Experimental investigations were conducted to determine the effect of x irradiation on areas of NaCl single crystals previously hardened by plastic strain. The $10 \times 10 \times 1$ cm specimens were stress-marked at a 200-g load. The markings were oriented with their diagonals parallel to the $\langle 100 \rangle$ axis. After etching, dislocation patterns (rosettes) appeared whose lines were perpendicular to the edges of the markings. A series of reference markings was made along some strain lines under a 3-g load. The microhardness of the reference markings was measured, and the length and width of the hardened area were established. The specimens were then exposed to direct x rays for 2, 5, and 10 hours, after which the microhardness of the unmarked lines was established. The results showed an increase of microhardness by about 2, 3, and 4 kg/mm^2 at the edge of the 200-kg stress markings at 2-, 5-, and 10-hour irradiation durations, respectively. The increases were greater (about 4, 6, and 7 kg/mm^2) in areas of lower prehardening, i.e., in spots farther removed (up to about 280 μ) from the maxima, which are at the edges of the prehardening markings. The phenomenon is ascribed to nonsymmetric defects accompanying the radiation-generated F centers on vacancies. The lower relative hardening at prehardened maxima is attributed to the vacancy pile-up at the prestrain maxima, which apparently, inhibit the generation of vacancies by radiation. (ATD)

13555 TRIVALENT RARE EARTHS IN CERIUM DIOXIDE SINGLE CRYSTALS DYSPROSIUM. Zoon, Z. N.; Katyshev, A. N.; Kurkin, I. N.; Shekun, L. Ya. (Kazan' State Univ., USSR. Inst. for Silicate Chemistry, Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 9: 1682-3(Jan. 1968).
Translated from Fiz. Tverd. Tela, 9: 2138-9(July 1967).

EPR spectra of dysprosium-doped (~0.1%) CeO_2 single crystals grown from melt were investigated. The virgin crystals were black and opaque and their spectral line width at 9370 MHz and 4.2°K was of the order of 30 Oe. After annealing in an oxygen atmosphere at ~1200°C, the crystals turned yellow and lost their opacity. Cubic and trigonal Dy^{3+} centers were observed. The hyperfine structure resulting from ^{161}Dy and ^{163}Dy isotopes was clearly observed in the samples. Results indicate that Dy^{3+} ions in CeO_2 can form trigonal centers with various properties. This also applies to Er^{3+} and Yb^{3+} ions. (ATD)

13556 OPTICAL PROPERTIES OF SOME TRANSITION METALS. Juenker, D. W. (Univ. of Vermont, Burlington); LeBlanc, L. J.; Martin, C. R. J. Opt. Soc. Amer., 58: 164-71 (Feb. 1968).

The optical constants of molybdenum, tantalum, tungsten, and rhenium have been measured at wave-lengths from 537 through 5770 Å by the reflectance vs angle of incidence method. The spectra for the two parts of the complex dielectric constant exhibit structural similarities among the four metals, consisting of three broad, partially overlapping absorption bands situated in the approximate photon-energy regions between 13 and 26 eV, between 7 and 15 eV, and below 10 eV. The latter band generally has one or more narrower absorption resonances superimposed on it. The observed structure bears a resemblance to the level separations calculated by Mattheiss for tungsten and rhenium, but correlation with specific transitions has not been pursued in detail. The f-sum rule applied to the imaginary part of the dielectric constant yields appropriate values of 5 and 7 electrons/atom for tantalum and rhenium. For molybdenum and tungsten the corresponding values are near 8, rather than the anticipated 6, electrons/atom. (auth)

13557 ELECTRICAL PROPERTIES OF INVERSION LAYERS PRODUCED IN SILICON BY BOMBARDMENT WITH PHOSPHORUS AND ALUMINUM IONS. Vasil'ev, V. K.; Zorin, E. I.; Pavlov, P. V.; Tetel'baum, D. I. (Lobachevskii State Univ., Gorkii, USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 1503-7(Jan. 1968).
Translated from Fiz. Tverd. Tela, 9: 1905-10(July 1967).

Experimental data are reported on the electrical conductivity and Hall effect in inversion layers produced in silicon by bombardment with phosphorus and aluminum ions. A study was made of the dependence of the surface resistance, as well as (in the case of phosphorus-ion bombardment) of the average density and Hall mobility of carriers, on the radiation dose and heat-treatment conditions. The surface resistance of phosphorus-bombarded silicon varied nonmonotonically with the dose at fairly low annealing temperatures, while in the case of the aluminum-bombarded material the nonmonotonic dependence was observed at all the investigated annealing temperatures. Increase of the resistance at high doses was due to the formation of an amorphous layer. When the temperature was increased the dependence of the resistance of the phosphorus-bombarded material on the dose became nearly monotonic, but in the case of aluminum bombardment the nonmonotonic nature of the dependence was maintained. (auth)

13558 MIGRATION OF EXCITONS IN URANYL SALTS. Abramov, A. P.; Abramova, I. N.; Tolstoi, N. A. Sov. Phys.-Solid State (Engl. Trans.), 9: 1516-18(Jan. 1968).
Translated from Fiz. Tverd. Tela, 9: 1923-6(July 1967).

According to theory, the relative yield of luminescence should remain constant if the quantity $\tau_0^{\frac{1}{2}}E$ is constant (E is the excitation intensity, τ_0 is the lifetime in the weak excitation case). It is shown experimentally that this condition is satisfied if the overlap of the absorption and luminescence spectra remains constant when τ_0 varies (the value of τ_0 was varied by introduction of photogenerated quenching centers). (auth)

13559 INTERACTION BETWEEN RADIATION DEFECTS AND DISLOCATIONS IN GERMANIUM. Khainovskaya, V. V.; Smirnov, L. S. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 1603-6(Jan. 1968).
Translated from Fiz. Tverd. Tela, 9: 2043-6(July 1967).

Creep of dislocations following capture of interstitial atoms during electron irradiation was investigated. A dependence of the creep of dislocations on temperature and total radiation flux was observed. A mechanism is proposed for this phenomenon, taking into consideration the presence of two escapes of interstitial atoms. The ratio for the capture cross sections of the interstitial atom by the dislocation and by the vacancy is determined. Results indicate the presence of a barrier for annihilation of the interstitial atom and the vacancy of the order of 0.4 eV. (auth)

13560 FIELD-EMISSION STUDY OF THE ADSORPTION OF SODIUM ON FACES OF TUNGSTEN AND RHENIUM SINGLE CRYSTALS. Ovchinnikov, A. P.; Tsarev, B. M. (Inst. of Phys. and Tech., Moscow). Sov. Phys.-Solid State (Engl. Transl.), 9: 1519-24(Jan. 1968).
Translated from Fiz. Tverd. Tela, 9: 1927-34(July 1967).

An investigation is made of the adsorption of sodium on single-crystal faces of tungsten and rhenium. It is found, for all the faces investigated, that the adsorption of sodium leads to a reduction of

the work function, particularly when the work function of the face is high. (auth)

13561 MAGNETIC FIELDS OF THE NUCLEI OF ^{119}Sn IMPURITY ATOMS IN FERROMAGNETIC MATERIALS. Balabanov, A. E.; Delyagin, N. N. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 9: 1498-1502(Jan. 1968).

Translated from Fiz. Tverd. Tela, 9: 1899-1904(July 1967).

The Mössbauer effect is used to study the magnetic fields of the nuclei of ^{119}Sn impurity atoms in the ferromagnetic alloys Cu–Ni, Co–Ni, Fe–Ni and in the pure ferromagnets (Fe, Co, Ni). The magnetic field in Cu–Ni alloys is proportional to the magnetic moment of the alloy and does not depend on the environment of the impurity atom; on the other hand, the magnetic field in the Fe–Ni and Co–Ni systems is extremely sensitive to the local atomic configuration. The fields present when the concentration of iron or cobalt is as much as 20% are smaller than those acting on ^{119}Sn in pure nickel. When the Cu–Ni alloy becomes paramagnetic, the isomer shift is found to change in accordance with the increased electron density around the impurity atom nucleus. Values of -21 ± 2 and -30 ± 2 kOe are obtained at room temperature for the magnetic field acting on the impurity-atom nuclei of tin in, respectively, cubic and hexagonal cobalt lattices. In hexagonal cobalt, the field rose to 42 ± 3 kOe at 262 ± 6°K. (auth)

13562 SHIFT OF THE U-CENTER LOCAL MODE IN ISOTOPIC LITHIUM FLUORIDE. Sievers, A. J. (Univ., Freiburg I. B.); Pompi, R. L. Contract AT(30-1)-2391. Solid State Commun., 5: 963-6(Dec. 1967). (NYO-2391-54).

When ^{7}Li was replaced by ^{6}Li in lithium fluoride the local mode frequency of the U center was observed to shift by (+) 3.9 cm^{-1}. (auth) (UK)

13563 THEORY OF NMR IN FERROMAGNETICS WITH LOW CONCENTRATION OF MAGNETIC NUCLEI. II. Kurkin, M. I.; Turov, E. A. (Inst. of Physics of Metals, Sverdlovsk, USSR). Fiz. Metal. Metalloved., 24: 27-33(July 1967). (In Russian).

The shift and half width of the NMR line produced by interaction of nuclear spins with spin waves were studied in the case in which relaxation of the electron spin system resulted from exchange interactions and magnetic anisotropy. It was found that, in the second order of nuclear interactions with spin waves, the processes of spin-wave scattering on nuclear do not contribute to the frequency shift in NMR but lead to the broadening of the line. Interactions of transverse components of nuclear and electron spins lead to broadening and also to the NMR frequency shift. Effects of nuclear spin interaction with Fermi splitting in the excited electron system on the NMR line width were investigated. (tr-auth)

13564 ALTERNATIVE REPRESENTATION OF ENERGY LEVEL DIAGRAMS FOR NMR SPECTRA. Castellano, S. M.; Bothner-By, A. A. (Mellon Inst., Pittsburgh). J. Chem. Phys., 47: 5443-4(Dec. 15, 1967).

In the dual representation of energy level and transition diagrams, energy levels are represented by lines and the transitions between two levels by the points where the two corresponding lines intersect. The advantages of such a display include clarity, easy checks for consistency, etc. (D.L.C.)

13565 ELECTRONIC SPECTRUM OF SINGLE-CRYSTAL Dy_2O_3. Henderson, James R. (Douglas Aircraft Co., Santa Monica, Calif.); Muramoto, M.; Henderson, T. M.; Gruber, John B. J. Chem. Phys., 47: 5097-5101(Dec. 15, 1967).

The absorption spectra of single crystals of Dy_2O_3 observed at 10, 80, and 290°K were analyzed in the 0.26 to 40-μ wavelength region. Over 600 transitions from all eight crystalline Stark levels of the ground $^{6}H_{15}$ state to 40 excited J manifolds of the Dy^{3+} ion in C_2 sites were assigned. The observed spectrum is assigned with the aid of a calculation of "free-ion" energy levels of Dy^{3+} between the ground state and 36,000 cm^{-1}. The Racah parameters $E^1 = 6300$, $E^2 = 31.95$, $E^3 = 614.2$, and $\zeta = -1881$ cm^{-1}, all obtained by direct diagonalization and least-squared fitting, yield an rms deviation of 83 cm^{-1} between 31 observed and calculated free-ion energy levels. The $^{6}F_{\frac{1}{2}}$ state, and all states above 23,000 cm^{-1} are reported and analyzed for the first time in any crystal. (auth)

13566 VAPOR PRESSURE OF HOLMIUM. Wakefield, G. F.; Daane, A. H.; Spedding, F. H. (Ames Lab., Iowa). Contract W-7405-eng-82. J. Chem. Phys., 47: 4994-9(Dec. 15, 1967). (IS-715).

The vapor pressure of holmium was measured from 10^{-6} to 10^{1} torr using modifications of the Langmuir and Knudsen methods. A tube-type orifice permitted use of the Knudsen method at the higher pressures, with suitable corrections. Lowest pressures were measured using a graphite condenser surrounding a large area Langmuir sample, with the vaporized metal being trapped as the nonvolatile carbide. The vapor pressure of the solid α-holmium is given by $\log P_{torr} = (-15{,}137/T°K) + 8.426$, and the vapor pressure of the liquid by $\log P_{torr} = (-14{,}122/T°K) + 7.849$. The heat of vaporization and heat of sublimation (298°K) were 64.7 ± 0.5 and 70.6 ± 0.7 kcal/mole, respectively. The enthalpy change from α-solid to liquid holmium, corresponding to heats of fusion and transformation, was 4.6 ± 0.7 kcal/mole. (auth)

13567 COURSE OF SNOEK DAMPINGS IN TANTALUM IN RELATION TO THE NITROGEN CONTENT. Hantel, M.; Schittko, F.-J. (Univ., Bonn). Z. Angew. Phys., 24: 118-20 (Jan. 3, 1968). (In German).

Thin tantalum wire specimens (43 cm length, 0.5 mm dia), degassed in vacuum and loaded with different amounts of interstitially solved nitrogen (0.17 to 1.40 at. % N) were examined in a torsion pendulum apparatus as used by KE; frequency 1 cps, temperature range 250 to 500°C. The internal friction peaks, in normed and linearized form, gave the activation energy for the diffusion of nitrogen in the bcc tantalum lattice. Beyond that the measurements showed besides the well-known linear relation between the principal internal friction peak with the concentration of gas a quadratic dependence of the height of the secondary peaks from the nitrogen concentration; this is in good agreement with the results of Powers and Doyle. (auth)

13568 INVESTIGATIONS ON ELECTRON-IRRADIATED NaF AND RbF SINGLE CRYSTALS WITH THE HELP OF AN OVEN CRYOSTAT. Aiginger, H.; Vana, N. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Z. Angew. Phys., 24: 71-5 (Jan. 3, 1968). (In German).

An oven cryostat has been constructed for optical measurements of color centers in the temperature range from the temperature of liquid nitrogen to 150°C. It offers the possibility of irradiating alkali metal halides, especially highly hygroscopic ones, to investigate the absorption properties and to heat it up to 500°C within the same vacuum. Investigations of NaF and RbF are reported and the results are discussed in detail. (auth)

13569 HEAT CAPACITY OF EUROPIUM FROM 5 TO 300°K. Gerstein, B. C.; Jelinek, F. J.; Mullaly, J. R.; Shickell, W. D.; Spedding, F. H. (Ames Lab., Iowa). J. Chem. Phys., 47: 5194-5201(Dec. 15, 1967). (IS-1614).

The heat capacities of two samples of Eu have been measured, one in the range 12 to 300°K and another in the range 5 to 300°K. A sharp transition was found in the neighborhood of 88°K, the temperature of the peaks differing by 0.3°K in the two samples, and the height of the peaks differing by roughly a factor of 2. Reasonable values of lattice and electronic contributions yield a magnetic entropy of R ln 8 at room temperature in accordance with the ion core being divalent over the entire temperature range measured. This value for the magnetic entropy is not unambiguously determined by the analysis, however. The thermodynamic functions for the two samples agree at room temperature to within 0.2% and are found to be as follows: $(H^\circ_{298.15} - H^\circ_0)/T = 26.86$ J (g·at. wt·deg)$^{-1}$, $S^\circ_{298.15} = 77.81$ J (g·at. wt·deg)$^{-1}$. (auth)

13570 EFFECT OF FAST-NEUTRON IRRADIATION ON OPTICAL ATTENUATION IN COMPOUND SEMICONDUCTORS. McNichols, J. L.; Hayes, P.; Ginell, W. S. (Douglas Aircraft Co., Santa Monica, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 46-54(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Recently a model was proposed to account for anomalous infrared attenuation noted experimentally for fast-neutron-irradiated, compound semiconductors. The model represents neutron damage by localized phase transitions to a high-pressure metallic-like state. It is shown that this model not only accounts for the anomalous, continuous optical attenuation at photon energies less than the band gap, but also can explain the absorption edge fuzziness noted for neutron-irradiated GaAs. The optical attenuation produced by embedded metallic zones at frequencies above the absorption edge is derived, and it is shown that the metallic resonance absorption band is altered from the usual Lorentzian shape. It is shown that in GaAs irradiated with fast neutrons at sufficiently high doses the resonant absorption by the metallic phase can dominate the host semiconductor absorption. (auth)

13571 TRANSIENT RADIATION EFFECTS IN OPTICAL MATERIALS. Mace, Phillip N.; Gill, Dennis H. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 62-7(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

The use of the prototype Phermex electron accelerator to simu-

late high-dose-rate nuclear-radiation environments is discussed. The free electron density produced in optical materials by the beam from this machine, and that expected from a typical incident prompt-gamma radiation flux are compared. An experimental setup to measure the effects on the transmission of selected optical materials is described, and data obtained on these materials are presented. Transient or permanent loss of transmission was observed in optical glasses and GE-101 fused quartz, but no effect was seen in purified fused silica. Reflectivity of front-surface aluminum and dielectric mirrors was also checked and no effects were seen. (auth)

13572 INJECTION-LEVEL STUDIES IN NEUTRON-IRRADIATED SILICON. Curtis, O. L. Jr.; Germano, C. A. (Nortronics, Newbury Park, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 68-77(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

The dependence of carrier lifetime on excess density was investigated for neutron-irradiated silicon. Five bulk specimens of n-type (1.0 to 55 ohm-cm) and five of p-type material (2.2 to 56 ohm-cm) were employed. In all cases the lifetime was constant at low excess densities, increased to a value several times larger at excess densities near the equilibrium carrier density, and then decreased. An analysis of the data was performed on the basis of recombination at disordered regions. The effective barrier heights associated with disordered regions were small, about 0.05 eV in n-type silicon and about 0.07 eV in p-type material. These values represent a weighted average for these regions participating in recombination and tend to favor low values. Capture probability ratios and other parameters were also obtained. (auth)

13573 INFLUENCE OF IMPURITIES ON CARRIER REMOVAL AND ANNEALING IN NEUTRON-IRRADIATED SILICON. Bass, R. F. (Northrop Corp. Labs., Hawthorne, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 78-81(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

The influence of impurities on carrier removal and annealing has been investigated in neutron-irradiated silicon in the resistivity range from 0.5 to 50 ohm-cm. Carrier removal rates in n-type material are strongly dependent upon the crystal growth method and are lower in Czochralski-grown (oxygen-containing) material than in material grown by the vacuum-float-zone or LOPEX techniques. A slight dependence of the removal rate on the dopant impurity is observed in vacuum-float-zone material but not in Czochralski-grown material. The annealing behavior of n-type material is also very crystal-growth dependent. An annealing stage located between approximately 144 and 170°C is observed in vacuum-float-zone and LOPEX-grown material but not in material grown by the Czochralski method. The location of the stage is dependent upon the dopant impurity. Carrier removal at room temperature in p-type material is not influenced by the growth method or the dopant impurity. However, dopant effects are observed upon annealing. (auth)

13574 ELECTRON DAMAGE COEFFICIENTS IN P-TYPE SILICON. Barrett, M. J. (Exotech Inc., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 82-7(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Crucible grown p-type silicon, as used for the base of many commercial solar cells, exhibits a damage coefficient under electron bombardment that appears to involve a double defect in each recombination center. The damage coefficient has been fitted to an empirical formula that accounts for silicon resistivity and for energy of the bombarding particles. To apply this formulation to a practical evaluation of solar cell damage in orbit, two complications were considered. The first is the angular distribution of the space radiation incident on the cell. An experiment showed that electron flux, and not current, determines the extent of the damage. The second is the presence of a transparent coverslide over the cell. By the application of Monte Carlo data for the transmission loss and energy degradation of the electrons, modifications to the damage coefficient can be made to account for coverslide shielding. An exponential attenuation appears adequate to describe these shielding effects. The end product of this study is an analytic formula for the damage coefficient that allows a simple calculation of the damage caused by energetic electrons to n/p silicon solar cells with coverslides. (auth)

13575 TWO LEVEL MODEL FOR LIFETIME REDUCTION PROCESSES IN NEUTRON IRRADIATED SILICON AND GERMANIUM. Messenger, George C. (Northrop Corp. Labs., Hawthorne, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 88-102(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

A two-level model for recombination processes in neutron-irradiated silicon and germanium is proposed. This model successfully explains published experimental data for lifetime and lifetime damage constant as a function of resistivity, injection level, and temperature. (auth)

13576 RADIATION DAMAGE IN LITHIUM DOPED SILICON. Carter, J. R. Jr. (TRW Systems, Redondo Beach, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 110-15(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Majority carrier removal rates for electron irradiation were studied in lithium-doped float-zone silicon. The removal appears to be due to reaction of lithium donors with displacement products to form uncharged complexes. A time dependent removal was observed after termination of the radiation. An exponential removal of carriers with electron fluence was also observed. (auth)

13577 INJECTION DEPENDENCE OF TRANSIENT ANNEALING IN NEUTRON-IRRADIATED SILICON DEVICES. Gregory, B. L.; Sander, H. H. (Sandia Lab., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 116-26(Dec. 1967). (SC-R-67-1159).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Studies have been performed to explore accurately the injection level and temperature dependence of transient annealing in neutron-irradiated p- and n-type silicon. In p-type material, the annealing factor in the 0 to 0.1 second time interval is very sensitive to the minority carrier injection level. For example, by varying the injection level from 10^{-5} to 10^{-1}, the annealing factor at 0.001 second can be reduced from 10 to approximately 2. In contrast to the p-type results, the injection dependence observed in n-type silicon is very small and, furthermore, is in the opposite sense; i.e., an increase in the injection level causes an increase in the annealing factor. However, this study shows that this seemingly different behavior can be correlated on the basis of the hole-to-electron ratios of the different material types and resistivities. Annealing measurements performed in the temperature range from 180 to 300°K reaffirm the 0.3-eV activation energy previously found in p-type silicon and establish a value of 0.17 eV for n-type. (auth)

13578 ANNEALING CHARACTERISTICS OF NEUTRON IRRADIATED SILICON TRANSISTORS. Chott, J. R.; Goben, C. A. (Univ. of Missouri, Rolla). Contract AT(11-1)-1624. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 134-46(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

When a transistor is subjected to neutron irradiation, a component of base current proportional to neutron fluence is induced. From the effects of annealing on the base and collector currents, the conclusion was drawn that there is an apparent difference in the annealing characteristics between the neutral and the space-charge regions of the semiconductor device. (auth)

13579 TIME RESOLVED ELECTRON DEPOSITION STUDIES AT HIGH DOSE RATES IN DIELECTRICS. Dow, J.; Nablo, S. V. (Ion Physics Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 231-6(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

The grazing electron beam probe technique has been used to study the behavior of the electric field external to planar irradiated samples in vacuo. The trapped charge density can be determined from these data so that its behavior during and subsequent to the irradiation period can be studied with microsecond time resolution. Secondary phenomena associated with high-rate electron deposition of energy in dielectrics at dose rates from 10^8 to 10^{10} rads/sec are discussed and include charged particle emission, backscatter, and luminescence. The measurements have been conducted with simultaneous determination of the trapped charge level in the irradiated sample. (auth)

13580 SURFACE EFFECTS IN SILICON SOLAR CELLS. Brown, R. R. (Boeing Co., Seattle). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 260-5(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

Very low-energy protons (0.4 to 27.5 keV) were used to study surface effects in silicon solar cells. The types of solar cells tested included conventional cells of n/p and p/n construction, as well as recently developed lithium-doped p/n cells (supplied by Heliotek Inc.). A proton beam of selected energy was used as a probe to penetrate to specified depths within the cells. Characteristic V–I curves were obtained before, during, and after proton exposure. Proton-induced degradation of the cell characteristics were analyzed. Anomalous damage, including partially recoverable losses of open-circuit voltage and significant losses of maximum power, were identified with various regions of the cells by correlation with proton penetration depths. (auth)

13581 INFLUENCE OF ^{60}Co GAMMA IRRADIATION ON THE SURFACE AND BULK RECOMBINATION RATES IN SILICON. Littlejohn, M. A.; Lade, R. W. (North Carolina State Univ., Raleigh). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 6, 305-18(Dec. 1967).

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio. See CONF-670708.

An experimental investigation was conducted to determine the influence of ^{60}Co gamma irradiation on the surface recombination velocity in 100 ohm-cm n- and p-type silicon. Utilization of the technique of photoconductive decay to measure the surface recombination velocity requires the knowledge of the bulk minority-carrier lifetime in the material. For completeness, the effects of the irradiation on this material parameter are also presented. When etched samples of n-type float-zone-refined phosphorous-doped silicon were irradiated with ^{60}Co gamma rays, the surface recombination velocity exhibited a relative minimum as a function of the total gamma-ray exposure dosage. In general, the surface recombination velocity was strongly influenced by the gamma irradiation for n-type material. The surface recombination velocity of irradiated samples of p-type float-zone-refined boron-doped silicon seemed to be only slightly sensitive to gamma radiation. The velocity was a very slowly monotonically increasing function of total gamma-ray flux. In order to explain these observed variations of surface recombination velocity, a more complete mathematical model was formulated. The model includes the contribution due to recombination in the space charge layer near the surface to the effective surface recombination velocity at the beginning of this space charge region. Use of this model allowed the correlation of experimental and theoretical values of surface recombination velocity. When bulk minority-carrier lifetime vs reciprocal temperature data were curve-fitted to the Shockley–Read lifetime, the position of the radiation-induced bulk recombination center in the forbidden region could be determined. In n-type material the location of this center was 0.40 eV below the conduction band edge. There did not appear to be any other centers present which had any influence on the recombination process. For p-type material the center was located at 0.18 eV above the valence band edge, and again there was no indication that other recombination levels were present. (auth)

13582 RADIOLUMINESCENCE OF ZIRCONIUM SILICATES. Shul'gin, B. V.; Gavrilov, F. F.; Parshin, V. K.; Chukhlantsev, V. G. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 7, 122-4(1967). (In Russian).

Investigations were made of the photo-, cathode-, x-ray-, and radioluminescence of rare-earth activated alkali metal and alkaline earth zircons (Na_2ZrSiO_5, $Na_2ZrSi_2O_7$, $Na_4Zr_2Si_3O_{12}$, Na_2HfSiO_5, $K_2ZrSi_2O_7$, $Rb_2ZrSi_2O_7$, $BaZrSi_3O_9$, and $Ba_2Zr_2Si_3O_{12}$). The absolute quantum luminescence yield of $BaZrSi_3O_9$ excited by ultra violet light with the wave length of 265 nm was equal to 0.2. The brightness of cathode luminescence of zirconium silicates was 60 to 70% of the screens used with 18LK15 type electron-beam tubes. The basic characteristics of the zirconium silicates are tabulated. It is shown that luminescence spectra depend on the density of the excitation and the activator. The luminescence spectra of sodium zircons activated by gadolinium and proton excited are in the ultraviolet region. Activators Ce, Dy, Eu, Sm, Y, Sc, Cr, and Mn induced the appearance of other bands. The x ray luminescence spectra were similar to the spectra excited by protons. The scintillation pulse amplitudes as functions of energy were studied using specimens of Na_2ZrSiO_5(Gd) excited by ^{239}Pw α particles. The resolving power of the photomultiplier FEU-29 and AI-100 amplitude analyzer was 80 to 90%. The amplitude dependence on energy in the 2.8- to 5.12-MeV range was close to linear. (R.V.J.)

13583 DISTRIBUTION FUNCTION FOR THE TOTAL PATH OF AN IRRADIATION-GENERATED PRIMARY ATOM WITH A GIVEN ENERGY. Croitoru, M.; Grecu, D. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 19: 777-803(1967). (In Rumanian).

Removal of primary atoms from a crystal lattice by the incident radiation results in the creation of defects, changing the physical properties of the solid. Interaction of the primary atoms with the atoms of the lattice may be clarified only by making simplifying assumptions. Thus, the solid is considered a homogeneous and isotropic medium; the lattice atoms are assumed to cause a channeling effect at high energies while at low energies, focusing collisions are expected to occur. The exact theory of the displaced atom cascade requires that both effects be taken into account. Methods based on operational calculus or the theory of integral equations made it possible to determine the distribution function of the total path of primary atoms. The subject was examined by taking primary atoms with a given specific energy as example. For unequal masses, Fourier transforms were carried out. The rigid-sphere approximation was employed for exponential-type interaction potentials, using the derived technique to determine the distribution function for uneven masses in two limiting cases. (TTT)

13584 THEORY OF ELECTRON NUCLEAR DOUBLE RESONANCE IN EXTERNAL ELECTRIC FIELDS. Deryugina, N. I. (Inst. of Semiconductors, Kiev). Ukr. Fiz. Zh., 12: 1882-92(Nov. 1967). (In Russian).

ENDOR of F centers in NaCl-type crystals in the presence of external electric fields is considered. The spin Hamiltonian of the interaction of nuclei with the electric fields for the second and third shells is obtained. The corrections to the frequencies of the spin–nuclear transitions in a static electric field for the first, second, and third shells are determined, and the matrix elements of the transitions due to the electric component of the radio-frequency field for the second and third shells are calculated. The static electric field lifts the degeneration due to the equivalence of the two nuclei, which pass to each other in the operation of inversion with regard to vacancy. The alternating field causes transitions with the selection rules $\Delta m^1 = \pm 1, \pm 2$. (auth)

13585 ION IMPLANTATION OF SILICON. II. ELECTRICAL EVALUATION USING HALL-EFFECT MEASUREMENTS. Mayer, J. W.; Marsh, O. J.; Shifrin, G. A.; Baron, R. (Hughes Research Labs., Malibu, Calif.). Can. J. Phys., 45: 4073-89 (Dec. 1967).

Hall-effect and sheet-resistivity measurements have been made on silicon samples implanted with Sb, Ga, and As ions at energies between 20 and 75 keV. These measurements determined the weighted average of the number N_s of carriers/cm^2 and the carrier mobility in the implanted layer. A combination of Hall measurements and layer-removal techniques was used in some cases to obtain a more accurate value of the number of carriers/cm^2 and the depth dependence of the carrier concentration and mobility. For Sb implantations both temperature and dose affect the anneal characteristics. Silicon samples implanted with Sb at room temperature exhibited n-type behavior following anneal at 300°C, with little increase in N_s up to about 550°C anneal temperatures. A 600°C 10-minute anneal produced an order-of-magnitude increase in N_s. This change is associated with reordering of the amorphous layer created during room-temperature implantations. This amorphous layer is not produced in implantations made at temperatures above 450°C. In low-dose ($<10^{14}$/cm^2) Sb implantations at 500°C, N_s increased by a factor of 2 to 3 during anneal to 800°C. In high-dose ($>5 \times 10^{14}$/cm^2) Sb implantations, the carrier concentration exceeded the limit set by thermal equilibrium solubility of Sb in silicon. Under these conditions, annealing caused a decrease in N_s toward the value associated with the solubility. Such supersaturation effects were not observed in Ga and As implantations at 500°C. Annealing to temperatures of 800 to 900°C produced a one-to-two order-of-magnitude increase in the number of carriers/cm^2. In Ga implantations annealed to 800 to 900°C, the number of carriers/cm^2 increased approximately linearly with increasing dose and then leveled off at a value near that expected from thermal solubility. The Rutherford-scattering data in the preceding paper indicate that the difference in implantation behavior between various ion species is due to differences in the relative number of ions on substitutional sites. (auth)

13586 ENERGY LOSS, THE DETERIORATION DEPTH, AND THE LIGHT OUTPUT FOR HEAVY IONS IN ZnO: Zn. Hastings, L.; van Wijngaarden, A. (Univ. of Windsor, Can.). Can. J. Phys., 45: 4039-51(Dec. 1967).

Local regions on the surface of ZnO:Zn phosphor samples were deteriorated by a large number of low-energy ions. In this manner thin films that did not luminesce under ion bombardment were prepared. The phosphor samples were then scanned across energetic ion beams with sufficient energy to traverse the thin phosphor films. By comparing the luminescent response to this ion excitation in the damaged and undamaged portions of the phosphor surface, the total average energy losses of ^{1}H, ^{4}He, ^{14}N, ^{40}Ar, and ^{84}Kr in passing through the films were determined. It was found that the

energy losses for the heavier projectiles, when compared with the energy loss of hydrogen, are appreciably smaller than the energy losses predicted by the Lindhard and Scharff theory. The deterioration depth of the phosphor under prolonged bombardment is proportional to the speed of the damaging projectiles. (auth)

13587 MEASUREMENT OF THERMALLY STIMULATED CURRENT IN A NEUTRON IRRADIATED ZnS CRYSTAL. Kitagawa, Michiharu; Yoshida, Toshio; Shono, Yoshihiko. Annu. Rep. Radiat. Center Osaka Prefect., 7: 52-5(1966).

Thermally stimulated current in a neutron-irradiated ZnS single crystal has been measured. Two peaks of thermally stimulated current at about 130 and 260°K are remarkably decreased by neutron irradiation. These peaks are analyzed by four kinds of methods. Energy levels of carrier trapping centers corresponding to the peaks are estimated to lie at 0.32 and 0.56 eV below the conduction band. These trapping centers may be suggested to be associated with chemical impurities which compose complex centers with defects induced by neutron irradiation. (auth)

13588 PHOTOCONDUCTIVITY MEASUREMENTS OF NEUTRON-IRRADIATED ZnS. Shono, Yoshihiko; Yoshida, Toshio; Kitagawa, Michiharu. Annu. Rep. Radiat. Center Osaka Prefect., 7: 56-8(1966).

Photoconductivity measurements of a neutron-irradiated ZnS single crystal have been made at liquid nitrogen temperature and room temperature. Two bands of photoconductivity were observed both at liquid nitrogen temperature and room temperature. One of them whose peak is about 560 mμ appears after uv excitation and disappears after illumination with the light of its own band. This band is suggested to be due to the identical electronic process of the 540-mμ optical absorption band. The other band whose peak is about 470 mμ suffers little change by illumination with the light of its own band. The electronic process of this band and that of the 430-mμ optical absorption band are inferred to be different. (auth)

13589 STUDY OF IRRADIATED LiF SINGLE CRYSTALS BY X-RAY DIFFRACTION TOPOGRAPHY. Hidaka, Tsuneo; Futagami, Koji (Kyushu Univ., Japan). Kyushu Daigaku Kogaku Shuho, 39: 155-61(Aug. 1966). (In Japanese).

A study was made on irradiated LiF single crystals by x-ray-diffraction topography, using a very narrow beam. In the x-ray-diffraction topography, the Lang's method was used. The dimensions of a point defect and of the displacement ring formed by irradiation were very small, not detected by the technique, and many of the observations previously reported for the irradiated crystals (by Kubo and Wolf et al.) are probably false. (NSA of Japan)

13590 OSCILLATIONS OF BERYLLIUM RESISTANCE IN STRONG MAGNETIC FIELDS. Alekseevskii, N. E.; Egorov, V. S.; Dubrovin, A. V. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 249-51(Oct. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 793-6(Oct. 15, 1967).

The single-crystal Be sample (I⊥[0001], $\rho_{300°K}/\rho_{4.2°K} = 120$) was mounted in a 80 kOe field and rotated through 360° by means of a drive wire and a friction device. Resistance measurements were made. (M.O.W.)

13591 THERMAL CONDUCTIVITY OF QUASI SINGLE-CRYSTAL GRAPHITE AND EFFECTS OF NEUTRON IRRADIATION. I. MEASUREMENTS. de Combarieu, A. (Centre d'Etudes Nucleaires, Grenoble, France). J. Phys. (Paris), 28: 951-4(Nov.-Dec. 1967). (In French).

Measurements of the thermal conductivity K of a pyrolytic graphite annealed under pressure at high temperature have been made between 6 and 300°K. Both $K_{||}$ and $K_{\perp}$ parallel and perpendicular to the c axis have been measured successively. The results together with other physical properties show that this graphite is well ordered and very close to a single crystal. $K_{\perp}$ shows a maximum at about 110°K and $K_{||}$ a maximum at about 70°K. It is possible to state that the measurements of $K_{||}$ are very little affected by the contribution of $K_{\perp}$. In a first step, the effect of neutron irradiation has been studied only $K_{\perp}$ which is very sensitive to irradiation. With this near-ideal graphite a theoretical analysis of the heat-transport phenomena in graphite is possible and an approach to it is given by B. Dreyfus and R. Maynard in another paper. (auth)

13592 EFFECT OF TUNGSTEN CONTENT ON THE RESIDUAL RESISTIVITY OF ZONE-REFINED MOLYBDENUM. Evans, J. H.; Eyre, B. L. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Status Solidi, 25: K39-K41(Jan. 1, 1968).

Studies of molybdenum from four different sources having W contents varied over an order of magnitude showed that electron-beam zone refining did not significantly alter the W content. Other measurements showed that the residual resistivity of Mo is a linear function of the W content. It was also found that the C content of Mo could be reduced to the 2.5-ppM level either by zone refining or by heat treating in purified hydrogen. (A.G.W.)

13593 EFFECTS OF OXYGEN ADSORPTION AND LOW ENERGY ION BOMBARDMENT ON THE ELECTRICAL PROPERTIES OF CADMIUM SULPHIDE THIN FILMS. Hughes, D. M.; Carter, G. (Univ. Coll. of North Wales, Bangor, Eng. Univ., Liverpool). Phys. Status Solidi, 25: 449-53(Jan. 1, 1968).

The changes produced in the electrical properties of cadmium sulphide thin films following oxygen adsorption and low-energy ion bombardment are reported. High-purity cadmium sulphide thin films were prepared in an ultrahigh-vacuum evaporating chamber, and conductivity tests and adsorption and bombardment investigations were carried out without exposing the samples to atmospheric contamination. Changes in the electrical properties of the thin-film samples that can be directly attributed to either oxygen contamination or radiation damage at the surface were observed. (auth)

13594 X-RAY PRODUCTION AND THERMAL ANNEALING OF FRENKEL PAIRS IN KCl. Giuliani, G.; Reguzzoni, E. (Univ., Pavia, Italy). Phys. Status Solidi, 25: 437-48(Jan. 1, 1968).

The x-ray production and thermal annealing of α-centers (isolated negative ion vacancies) are studied in KCl as a function of purity and the temperature of irradiation. At any temperature the α-center production results from competition between the formation process and thermally activated destruction of negative ion vacancies. Since the latter process is strongly temperature- and structure-dependent, the α-center production is structure-sensitive or -insensitive depending on the temperature of irradiation. From the point of view of thermal stability the α centers produced by x rays can be divided into two groups. The first group includes α centers that decay below 77°K and whose thermal stability does not depend on the purity of the sample. The second group includes α centers that decay in the 100 to 250°K temperature range and whose thermal stability is strongly structure-sensitive. Finally, some results on the influence of electron traps on α-center formation are reported. (auth)

13595 STUDY OF FERMI SURFACES OF MOLYBDENUM DURING CYCLOTRON RESONANCE MEASUREMENTS. Herrmann, R. (Humboldt-Univ., Berlin). Phys. Status Solidi, 25: 427-35(Jan. 1, 1968). (In German).

Cyclotron resonance measurements on molybdenum at 1.6°K and 9.7 GHz lead to estimates of the electron effective mass components and their anisotropy in the (110) and (121) planes. For every orientation of the magnetic field in these planes several cyclotron resonance series are observed and this points to a complicated form for the Fermi surface of molybdenum. A part of the effective mass data is attached to a theoretical model of the Fermi surface. The velocity of the electrons moving round the central waist of the electron jack is estimated to be $v_c = 0.56 \times 10^8$ cm/sec. (auth)

13596 STRESS DEPENDENCE OF THE DISLOCATION VELOCITY IN MOLYBDENUM. Guiu, F. (Cambridge Univ., Eng.). Phys. Status Solidi, 25: 203-7(Jan. 1, 1968).

The exponent m^* in the velocity–stress relation $V = (\tau^*/\tau_0)^{m^*}$ is calculated from data on the strain-rate sensitivity of the flow stress of molybdenum single crystals. The values of m^* thus obtained (for different orientations of the crystals) are compared with those determined by other workers from measurements of edge dislocation velocities. Agreement is obtained only if the effective stress acting on the dislocations is assumed to be independent of the temperature. Since no justification can be found for this assumption, it is concluded that the parameters m^* and τ_0 may have different values depending on whether the above equation applies to the mobility of edge or screw dislocations. They may depend also on the mode of deformation, hence on the orientation of the crystals. (auth)

13597 DEFORMATION OF MOLYBDENUM SINGLE CRYSTALS AT SLOW RATES OF STRAIN. Guiu, F. (Cambridge Univ., Eng.). Phys. Status Solidi, 25: 189-202(Jan. 1, 1968).

Molybdenum single crystals were deformed in tension, and the relationship between stress, strain, and strain rate was studied in the preyield region. The high work-hardening rate of the preyield deformation is explained in terms of the exhaustion of mobile edge dislocation segments. The rate of exhaustion, $\partial \log \rho / \partial \epsilon$, is of the order of 10^3 to 10^4. The temperature and strain rate dependence of the stress required to deform the crystals at strain rates

$<10^{-7}$ s^{-1} was investigated at strains >0.01. The activation energy and activation volume have values between 2 and 4 eV, and between 50 and 100 b^3 respectively. This result suggests that the mechanism of overcoming the Peierls friction is not rate controlling at the slow rates of strain. Alternative interpretations are discussed. (auth)

13598 EFFECTS OF NEUTRON IRRADIATION ON PLASTIC DEFORMATION OF IRON SINGLE CRYSTALS WITH SMALL CARBON CONTENT. I. YIELD STRESS NEAR THE START OF DEFORMATION. Seidel, G. P. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Phys. Status Solidi, 25: 175-88 (Jan. 1, 1968). (In German).

An investigation is made of the mechanism of radiation hardening for iron single crystals with small amounts of carbon (20 and $\lesssim$9 ppM by weight). The dependence of the yield stress on the irradiation dose and the deformation temperature is measured and annealing experiments are performed. The radiation-induced increase of the yield stress is strongly dependent on the carbon content, saturates completely at a rather low dose (3×10^{17} n/cm^2) and recovers only above 230°C. The temperature dependence of the yield stress can be described by the interaction between the dislocation and defects with tetragonal symmetry. The results are interpreted in terms of dislocation obstacles, which are produced by neutron irradiation and which consist of complexes of carbon atoms and vacancies or interstitials. (auth)

13599 FIELD ELECTRON MICROSCOPE STUDY OF NIOBIUM SURFACES. Savage, William R. (Univ. of Iowa, Iowa City). Phys. Status Solidi, 25: 131-8(Jan. 1, 1968).

An account is presented of field-emission experiments on contaminated and clean niobium surfaces. It is concluded that the equilibrium thermal end-forms of niobium single-crystal emitters consist of small flat regions of low-index crystallographic directions smoothly joined by transition planes to give a shape close to spheroidal. Fowler–Nordheim graphs of the voltage–current characteristics of the thermally cleaned cathodes gave a work function of (4.1 ± 0.1) eV, which agrees with the results of other measurements. (auth)

13600 THERMO- AND ELECTROTRANSPORT IN β-TITANIUM AND β-ZIRCONIUM. Duebler, H.; Wever, H. (Technische Univ., Berlin). Phys. Status Solidi, 25: 109-18(Jan. 1, 1968). (In German).

In β Ti and β Zr with a purity of almost 99.9% thermotransport occurs towards the hot end of the specimen and electrotransport towards the anode. The ratio of the heat of transport Q* (in kcal) to the effective charge z* is 43 for β Ti and 55 for β Zr. The activation energy for the thermotransport is about 27 kcal for β Ti and 16 kcal for β Zr. For β Zr this is distinctively different from the known values for self-diffusion. These measurements show that the anomalous behaviour of diffusion in the investigated metals cannot be explained by Zener's ring mechanism. A consistent explanation of all the results can, however, be obtained by postulating a dislocation mechanism in which the region of enhanced diffusion around the dislocation core is larger for β Ti than for β Zr. (auth)

13601 HIGHER-ORDER ELASTIC CONSTANTS IN hcp CRYSTALS. Rose, M. F.; Ramsey, R. T. (Naval Weapons Lab., Dahlgren, Va.). Phys. Status Solidi, 25: 103-8(Jan. 1, 1968).

Expressions for the elastic constants for hexagonal close-packed lattices are derived through third order, assuming the atoms interact through a central potential function. These expressions are then evaluated, using the Morse and Rydberg potential functions, for Be, Mg, Zn, Cd, and Tl. Comparisons are made between theory and experiment wherever possible. The effect of the axial ratio of the hcp lattice on the elastic constants is discussed, and it is shown that both potential functions lead to lattice instabilities for Zn and Cd. (auth)

13602 ANALYSIS OF THERMAL CONDUCTIVITY OF GRAPHITE. II. THEORY. Dreyfus, B.; Maynard, R. (Centre de Recherches sur les Tres Basses Temperatures, Grenoble, France. CEN, Grenoble, France). J. Phys. (Paris), 28: 955-66(Nov.-Dec. 1967). (In French).

A quantitative description is given of the thermal conductivity of quasi-monocrystalline graphite, both irradiated and nonirradiated, using detailed phonon dispersion relations and envisaging various scattering mechanisms. The existence of both a strong crystallite form anisotropy ($\approx 10^2$) and localized defects within the graphite layers which lead to a relaxation time τ^{-1} proportional to ω^3 is demonstrated. It is concluded that type-I interstitials exist in irradiated graphite giving abnormal relaxation times which lead to a conductivity proportional to $T^{1.5}$ at low temperature and depending on the number of defects n′ as $(n')^{-0.5}$. (auth)

13603 ON THE OPTICAL ABSORPTION OF X-RAY-IRRADIATED $NaClO_3$ CRYSTALS. Rasanen, Vilho; Esselstrom, Raili (Univ. of Turku, Finland). Ann. Acad. Sci. Fenn., Ser. A VI, No. 256, 1-8(1967).

The optical absorption of x-irradiated $NaClO_3$ crystals has been investigated at room temperature in the wavelength region of 0.2 to 25 μ. Several new absorption bands have been observed in the infrared part of the spectrum. The effect of thermal and optical bleaching on the ultraviolet and infrared bands induced by irradiation has been studied. The irradiations and measurements in the wavelength region of 0.2 to 2.5 μ have also been performed at liquid air temperature. Furthermore, the effect of optical bleaching on the bands observed at low temperatures has been investigated. (auth)

13604 NEUTRON SCATTERING FROM PARAMAGNETIC CHROMIUM HALIDES. Rao, L. Madhav; Murthy, N. S. Satya; Venkataraman, G.; Iyengar, P. K. (Bhabha Atomic Research Centre, Bombay). Phys. Lett., 26A: 108-9(Jan. 1, 1968).

Using the cold neutron inelastic technique, exchange integrals have been measured in $CrBr_3$ and CrF_3 in their paramagnetic phase. (auth)

13605 RELATIVE STRAINS INDUCED BY X-IRRADIATION DAMAGE IN SEVEN ALKALI HALIDES NEAR 20°K. Martel, Charles Peter. Toronto, Univ. of Toronto, 1966. Thesis.

X-ray induced strains were measured at 20°K in LiF, NaF, KF, NaCl, KCl, KBr, and NaI, irradiated with x rays from a commercial tungsten-target x ray tube with x ray qualities ranging from 23 to 100 kVp. The dilations or strains induced in KCl were found to be about 43 times greater than those in NaCl for roughly similar absorbed 68-kVp, 10-mA energies. Comparisons of the various strains were made with existing F-center coloration data and interpretations were made by noting similarities in strain and coloration results. Strains in KF, NaF, KCl, and KBr were found to be proportional to interstitial ion volumes and a roughly similar yield of Frenkel defects per unit energy absorbed is indicated for these four salts. Optical bleaching of x-ray-induced coloration in KCl was found to produce no concurrently detectable change in strain at temperatures near 20°K. In NaCl, heating effects appear to enhance the damage mainly in the beginning period of the irradiation; this is so to a much smaller degree in easily damaged salts such as KBr and KCl. It was found that the rate of strain observed on irradiation at 20°K in KCl and NaCl did not depend on the initial state of strain of the crystal. The measurements indicate that higher Frenkel defect production yields are obtained per unit absorbed energy in proceeding from 68 kVp to lower x-ray qualities. An interpretation of the relative strain rates was attempted using elementary elastic theory and Ritz's model of defect production for these irradiations. (Diss. Abstr.)

13606 PROPERTIES OF SOLIDS AND THEIR ATOMIC STRUCTURES. Bowen, H. J. M. London, McGraw-Hill, 1967. 154p. 28s.

The subject is reviewed under the following headings: introduction to solids; molecular solids; covalent solids; ionic solids; metals; semiconductors and defective solids; symmetry and crystal notation. (UK)

13607 MICROWAVE MAGNETIC RESONANCE AND ABSORPTION IN DYSPROSIUM SINGLE CRYSTALS. Blackstead, Howard Allen. Houston, Tex., Rice Univ., 1967. 164p. Thesis.

Microwave power absorption has been observed at a frequency of 9.45 GHz in single-crystal c-plane platelets of dysprosium at temperatures from 40 to 179°K. The dc magnetic field was aligned parallel to an a-axis (easy axis) or a b-axis (hard axis), with the rf field either perpendicular, parallel, or at an angle of thirty degrees to it. At temperatures below 85°K, and for temperatures from 85°K to approximately 95°K with $H_{dc} > H_f$, a strong resonance line with a width of approximately 1 kOe was observed. This resonance, predicted from spin-wave analysis, is apparently related to the strong sixfold basal-plane anisotropy, which is important below 120°K. With the dc field along an easy axis, and rf field perpendicular to it, a very strong resonance was observed at temperatures from 75 to 155°K. In the antiferromagnetic state, the resonance occurs at H_c for temperatures less than 125°K, but above 125°K, the resonance occurs for $H_c < H < H_f$. The line width is proportional to the temperature; however, the proportionality constant changes abruptly in a small temperature interval near 125°K from 1.6 Oe/°K for T < 125°K to 476 Oe/°K for T > 125°K. With the dc field perpendicular to the rf field, and for temperatures above 85°K, there was no apparent field dependence of the absorption for $H_{dc} < H_c$. At higher fields, however, the absorption increases rapidly, reaching a maximum just above H_c. With

further increase of the field, the absorption decreases linearly. With the fields parallel, the maximum absorption occurs at H = 0, decreasing nearly linearly with H until near H_c, the dependence changes to approximately H^{-1}, and, at the highest field available, the absorption is still decreasing slowly. No absorption was observed above 179°K, the temperature for the transition from the helicoidal spin structure to the paramagnetic state. A theory is developed which assumes an adiabatic nonresonant process in which the magnetic moments "follow" the rf field in such a way as to minimize the free energy of the magnetic system. The theory, employing the enormous magnetoelastic coupling as an energy loss mechanism, gives good qualitative agreement with the observed broad field dependent power absorption. An equation of motion approach to calculate the resonant frequency for the antiferromagnetic state as a function of magnetic field has been generalized to include magnetoelastic coupling and the basal plane anisotropy, and is carried to third order in the magnetic field. (Disser. Abstr.)

Theoretical Physics

Refer also to abstract 13868.

13608 (BNL-50080) THE DYNAMIC STRUCTURE OF LIQUIDS. Brookhaven Lecture Series Number 59. Paskin, Arthur (Brookhaven National Lab., Upton, N. Y.). Sept. 28, 1966. 10p. Dep. CFSTI.

It is shown that the computer combined with Newtonian mechanics is a powerful tool for gaining insight into the structure and atomic motions in the liquid and solid states. These computer calculations give quantitative information to compare with experiment. These calculations also can provide three-dimensional films which may ultimately help one to arrive at the basic mechanisms of crystallization and melting. (W.D.M.)

13609 (ANL-Trans-551) QUANTUM FIELD PERTURBATION THEORY IN THE CASE OF TWO STATES IN OPEN SHELLS (FIRST AND SECOND ORDERS IN PERTURBATION THEORY). Safronova, U. I.; Tolmachev, V. V. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Liet. Fiz. Rinkinys, Liet. Tsr Mokslu Akad., Liet, Tsr Aukst. Mokyklos, 4: 249-61(1964). 13p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Perturbation theory is investigated with the aid of Gell-Mann and Low adiabatic theorem formula in the first and second orders in the case of two occupant states in the open shells. The results are illustrated in Feynman diagrams with denominators. (auth)

13610 RADIATIVE TRANSFER IN RELATIVISTIC MEDIUM. Hameen-Anttila, K. A. (Univ. of Oulu, Finland). Ann. Acad. Sci. Fenn., Ser. A VI, No. 251, 1-24(1967).

The theory of radiative transfer is developed in a general-relativistic form. The transformation equations derived for radiation quantities show that Kirchhoff's law relating the coefficients of emission and absorption is an invariant law, if written in an appropriate fashion. Tolman's law for the equilibrium distribution of temperature turns out to be a special case of a more general law. A correction term for nuclear energy production in supermassive stars is derived. (auth)

13611 STABILIZATION OF UNSTABLE RESOLUTION-CORRECTION PROBLEMS. Aurela, A. M.; Torsti, J. (Univ. of Turku, Finland). Ann. Acad. Sci. Fenn., Ser. A VI, No. 255, 1-17(1967).

The resolution-correction equation $\int K(x,y)f(y)dy = g(x)$ or, in the matrix form, $Af = g$ is considered in the case of instability (A nearly singular). Methods are developed for the stabilization of the problem in cases when f(y) is known to be monotone, concave, or convex. The methods are based on use of non-negativity constraints on the first or second finite differences of f(y). Several tests were carried out using artificial examples in which the true f(y) was known. A comparatively good estimate of an unstable vector f with 21 components was worked out with the IBM 1130 in one hour. A much better result was obtained by continuing the relevant iteration for 4 hours. The constraints proved to be free of unphysical bias. A comprehensive classification is given for the various stabilizing constraints used by different authors. 114 references. (auth)

13612 FREQUENCY MIXING IN SCATTERING OF ELECTROMAGNETIC WAVES BY FREE ELECTRONS. I. CLASSICAL THEORY. Prakash, H.; Vachaspati (Univ. of Allahabad, India). Nuovo Cim. (10), 53B: 24-33(Jan. 11, 1968).

It is shown that if the incident electromagnetic wave contains two frequencies, the wave scattered from free electrons contains a complete spectrum of the combination frequencies in addition to the fundamentals, second harmonics and summation and beat frequencies. The expressions for the scattering cross sections of the summation and beat frequencies differ from those of Fried and Frank but are in agreement with our quantum-theoretical results. It is also shown that the scattering cross section increases in the presence of a very-low-frequency wave of high intensity because, in this case, the summation and beat frequencies are the same as the greater of the two frequencies and therefore the energy scattered into these combination frequencies should be added to that into the greater of the two fundamental frequencies. This increase is enormous when the ratio of the two frequencies approaches zero. This may make it possible to reduce very appreciably the time of exposure of sensitive films in x-ray experiments by irradiating the scatterer simultaneously by a maser beam also. (auth)

13613 FREQUENCY MIXING IN SCATTERING OF ELECTROMAGNETIC WAVES BY FREE ELECTRONS. II. QUANTUM THEORY. Prakash, H.; Vachaspati (Univ. of Allahabad, India). Nuovo Cim. (10), 53B: 34-42(Jan. 11, 1968).

Nonrelativistic quantum field theory has been used to calculate the scattering cross sections for the summation and beat frequencies when two electromagnetic waves are simultaneously incident on free electrons. The results, which differ from those of Fried and Frank, are supported by the authors' classical results. When the ratio of the two frequencies is small, the scattering cross sections of the summation and beat frequencies which now become almost the same as the larger of the two frequencies are enormous. The scattering cross section therefore increases in the presence of a low-frequency, high-intensity wave. This fact may enable one to reduce the time of exposure of sensitive films in x-ray scattering experiments by irradiating simultaneously the scatterer by a maser beam also. (auth)

13614 EFFECTS OF PERTURBATIVE FORCES ON THE MOTION OF CHARGED PARTICLES IN A DIPOLAR MAGNETIC FIELD. Bekaert, F.; Lemaire, J. Bull. Cl. Sci., Acad. Roy. Belg., 53: 833-50(1967). (In French).

The motion of low-energy charged particles in a geomagnetic field disturbed by electric and centrifugal forces is examined, using Alfven's and Fälthammar's method. It is shown that in this case, charged particles mirror at a position which depends on the pitch angle and on kinetic energy. Different integrals characterizing the mirror oscillations and azimuthal drifts are evaluated versus kinetic energy. Results are tabulated and illustrated. (auth)

13615 ACTION AND THE FORMULATION OF QUANTUM MECHANICS. Talpe, J. (Univ. Leuven, Sao Paulo, Brazil). Ned. Tijdschr. Natuurk., 33: 307-22(Oct.-Nov. 1967).

The fact that action is quantized is taken as the base for dealing with quantum mechanics. After stating the fundamental question of physics in a formal language a discussion is given of the classical answer: nature economizes action. This answer is then shown to become meaningless because action is quantized. It is replaced by the quantum-mechanical answer: linear superposition of amplitudes. In this way one arrives at an equation essentially proposed by Feynman which serves as a fundament for developing quantum mechanics. The Schrödinger equation is deduced and a suggestive interpretation is given to the operators of quantum mechanics. The expression for the expectation value is also deduced. From the very beginning bra's and ket's are meaningfully introduced and one arrives straightforward into the formalism of quantum mechanics. (auth)

13616 REMARK ON MACKEY'S AXIOM SYSTEM FOR QUANTUM MECHANICS. Maczynski, M. J. (Technical Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 583-7(1967).

The same conclusion derived by Mackey with his 6 axioms is derived here for only 3 axioms. (M.O.W.)

13617 ON THE GENERALIZED SCHROEDINGER EQUATION. de la Pena-Auerbach, L.; Garcia-Colin, L. S. (Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis., 16: 221-32(1967).

A derivation of a generalized Schroedinger equation valid for velocity-dependent forces, is presented. The physical assumptions involved rest on the hypothesis that a more general quantum mechanical description of a particle may be constructed by starting from a Markoff process as described by Fokker-Planck's equation in phase space. It is also shown that the asymptotic limit leads to the ordinary formalism of quantum mechanics in configuration space together with a new equation in velocity space which allows us to generate quantum numbers which are tentatively associated with some of those characteristic of the particle. This formulation leads to a first estimate of the parameter β introduced in previous papers. (auth)

13618 EFFECTIVE POTENTIAL DESCRIPTION OF THE QUANTUM IDEAL GASES. Lado, F. (Los Alamos Scientific

Lab., N. Mex.). J. Chem. Phys., 47: 5369-75(Dec. 15, 1967). (LA-DC-8966).

An attempt is made to describe the quantum ideal gases by means of a classical Boltzmann factor using an effective pair potential. The n-body distribution function is found for ideal gases of spin 0 and the n = 2,3 cases, generalized for spin s, are used with the Born–Green hierarchical relation to obtain an integro-differential equation for the effective potential. Several numerical solutions for both the Bose–Einstein and Fermi–Dirac ideal gases are presented. (auth)

13619 COORDINATE AND MOMENTUM OBSERVABLES IN AXIOMATIC QUANTUM MECHANICS. Gudder, Stanley (Univ. of Wisconsin, Madison). J. Math. Phys. (N. Y.), 8: 1848-58 (Sept. 1967).

An axiomatic model for quantum mechanics is formulated using physically significant axioms. The model contains a slight strengthening of Mackey's first six axioms, together with two axioms which ensure the existence of coordinate and momentum observables. The symmetries or rigid motions are an essential part of the structure, and a link is constructed between these and the quantum proposition system. Coordinate and momentum observables are defined in terms of abstract coordinate systems and one-parameter groups of motions. It is then shown that as far as the statistical properties of these observables in certain canonical states are concerned, the abstract model may be represented by the usual Hilbert space formulation. Spectral properties of σ-homomorphisms are also investigated. Also included are two appendices of a technical nature: the first considers one-parameter groups of derivables, and the second absolutely continuous σ-homomorphisms. (auth)

13620 PERTURBATIONS IN INTENSIVE BEAMS OF CHARGED PARTICLES WITH A CONSTANT DIAMETER FOCALIZED BY A UNIFORM MAGNETIC FIELD. Mineev, F. I. (Physico-Technical Inst., Kharkov). Ukr. Fiz. Zh., 12: 1873-7(Nov. 1967). (In Russian).

The equation of paraxial beam motion was solved for systems with axial symmetry, using a term which takes into account the volumetric charge of the beam under specified conditions. (TSS)

13621 DEVELOPMENT OF THE ELECTROMAGNETIC FIELD CONCEPT. (FARADAY AND MAXWELL). Biro, Gabor (Technical Univ., Budapest). Fiz. Szemle, 17: 292-7(Oct. 1967). (In Hungarian).

The development of the electromagnetic field concept was examined. The Coulomb laws are based on Newton's force concept and may be derived from the potential law. From the historical point of view, W. Weber's fundamental electrodynamic law, attempting to combine Coulomb's and Ampere's laws, is of special interest, but the first and still valid solution of the action of forces is represented by the Faraday–Maxwell field theory. Faraday emphasized the unitary character of nature, pointing out the physical reality of magnetic and electric lines of force and demonstrating the mathematical analogy between the behavior of electric current, heat flow, and the electric and magnetic lines of force. Maxwell was his intellectual heir; he may be considered as the father of the currently accepted field of force concept. His mechanical model of electromagnetic phenomena was published in a series of papers during 1861-62. He concluded that magnetism is a rotational phenomenon, while the electric current is a translational one. The true meaning of the Faraday–Maxwell field theory was not understood by their contemporaries and a half-century passed before the physical field concept, the theory of relativity, was developed. (Historical review, 43 references). (TTT)

13622 PROPERTIES OF A PARTICLE IN A ONE-DIMENSIONAL RANDOM POTENTIAL. Halperin, B. I. (Ecole Normale Superieure, Paris). Advan. Chem. Phys., 13: 123-77 (1967).

The subject is reviewed under the following headings: Introduction; definition of models; examples of random systems; analytic method—general considerations; cumulative density of states (node counting, Monte Carlo method, analytic method); Green's functions (momentum-dependent spectral density, frequency-dependent electrical conductivity); alternate analytic procedures for the density of states; difference between discrete and continuous random parameters; numerical calculations; energy gaps; localisation of wave functions; absence of dc conductivity. 41 references. (UK)

13623 SYMPOSIA ON THEORETICAL PHYSICS. VOLUME 5. Ramakrishnan, Alladi (ed.). Lectures Presented at the 1965 Summer School of the Institute of Mathematical Sciences, Madras, India. New York, Plenum Press, 1967. 228p. $12.50.

Thirteen lectures are included; separate abstracts are prepared for ten. Lectures not abstracted for NSA deal with certain external problems, fluctuating density fields and Fokker–Planck equations, and a pattern in functional analysis. (L.B.S.)

For abstracts of individual papers see: 13624–13626, 13721, 13788–13790, 13837, 13854, and 13928.

13624 LECTURES ON NESTED HILBERT SPACES. Grossmann, Alexander (MATSCIENCE, Madras). pp 1-13 of Symposia on Theoretical Physics. Vol. 5. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

Lectures are presented dealing with a class of vector spaces that are convenient tools for the investigation of some questions in scattering and quantum field theory. Calculations are carried out in essentially the same manner as in Hilbert space, with the qualification that products are defined only if certain initial and final subsets of a partially ordered set have a non-empty intersection. The following topics are discussed: algebraic inductive limit, definition of nested Hilbert space, scalar product, nested Hilbert space associated to an orthonormal basis, operators, the nested Hilbert space $\mathcal{S}_1^{(d)}$, product of operators, and the adjoint. (L.B.S.)

13625 ELEMENTARY HOMOLOGY THEORY. Ranganathan, N. R. (MATSCIENCE, Madras). pp 15-28 of Symposia on Theoretical Physics. Vol. 5. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

The simplicial homology theory is developed following an introduction to the notions of chains, cycles, and boundaries. The properties of simplicial mapping are briefly dealt with; it is shown how a homomorphism is induced between homology groups. The relative homology theory is described, arriving at the exact sequence between homology groups. (L.B.S.)

13626 CORRESPONDENCE PRINCIPLES IN DYNAMICS. Arens, Richard (Univ. of California, Los Angeles). pp 185-210 of Symposia on Theoretical Physics. Vol. 5. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

A precise framework in which the correspondence principle can be formulated is presented; the correspondence principle is then proved. The required differential geometry of dynamics is reviewed. (L.B.S.)

13627 LECTURES ON QUANTUM STATISTICS. VOLUME 1. QUANTUM STATISTICS. Bogolyubov, N. N. New York, Gordon and Breach, Science Publishers, 1967. 250p.

Translated from the Ukranian.

The basic principles of quantum statistical mechanics are discussed. The 1, 2, ..., n, particle density matrices are also introduced and the equations of motion which lead to the BBGKY hierarchy are derived. Probability distributions in momentum space and fluctuations of particle number in a region in configuration space and a comprehensive treatment of method of second quantization based on the original concepts introduced by Fock are described. The fundamental ideas are introduced and carefully discussed for the separate cases of Fermi and Bose statistics and the connection with method of statistical operators developed. The Bose–Einstein gas and applications to superfluidity are discussed. Landau's theory of superfluidity is presented and a rigorous justification of its postulates from the microscopic theory of Bogoluibov is given. A detailed exposition of the polar theory of metals is included. Second quantized notation is used throughout and operator algebra techniques are utilized. These techniques are used to develop a perturbation theory method which leads to an "effective Hamiltonian" for the polar model of a metal. In addition, operators are introduced which permit a calculation of the electric current associated with the spin waves. (M.H.R.)

13628 MANY-ELECTRON SYSTEMS: PROPERTIES AND INTERACTIONS. Fraga, Serafin; Malli, Gulzari. Studies in Physics and Chemistry. Number 7. Philadelphia, W. B. Saunders Company, 1968. 208p.

The many aspects of the hamiltonian operator and eigenequation for both free molecules and those subjected to electric and magnetic fields are connected. Thus, topics apparently distinct as charge densities, magnetic susceptibilities, nuclear quadrupole resonance, and x-ray diffraction are shown to develop logically from the consideration of operators, eigenfunctions, tensors, and the concepts of perturbation and variation theory. Numerous chemical examples, tabulated results, and a literature survey at the end of each topic are included. (M.H.R.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 13689.

13629 (AED-C-23-19) HIGH ENERGY PHYSICS INDEX. Volume 5, Number 11. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1967. 180p. Dep.

Five hundred and twenty four references are presented on experimental and theoretical high energy physics. Author, report number, and subject indexes are included. (B.G.D.)

13630 PARTICLES AND ACCELERATORS. Gouiran, Robert. World University Library. New York, McGraw-Hill Book Company, 1967. 256p. $2.45.

Translated by W. F. G. Crozier.

After brief descriptions of elementary particles and a historical review of their discovery are presented, recent achievements in high energy physics, emphasizing observable phenomena and experimental results, are discussed. The recent achievements include quantum theory, first mesons, antiparticles, strange particles, particle interactions, symmetries CPT and negative time, resonances, group theory, and the quantum phenomenon. The high-energy accelerators and associated equipment used for production and detection of elementary particles are examined. (B.G.D.)

Electromagnetic

Refer also to abstracts 13262, 13263, 13877, and 13926.

13631 (DESY-67/30) PHOTOPRODUCTION OF ρ^0 MESONS ON HYDROGEN, CARBON, AND ALUMINIUM WITH PHOTONS OF KNOWN ENERGY. Blechschmidt, H.; Dowd, J. P.; Elsner, B.; Heinloth, K.; Hoehne, K. H.; Raither, S.; Rathje, J.; Schmidt, D.; Smith, J. H.; Weber, J. H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct. 1967. 13p. Dep.

Photoproduction of pion pairs on hydrogen, carbon, and aluminum at photon energies between 3.2 and 4.9 GeV was investigated in a spark chamber experiment in order to study the production of ρ^0 mesons. Values were obtained for ρ^0 masses from a Breit–Wigner fit, which are in good agreement with other experiments. Total and differential cross sections for the process $\gamma + A \rightarrow \rho^0 + A$ were also obtained. The energy dependence of the forward cross section was found to exhibit a behavior in accord with diffraction production. (L.B.S.)

13632 (DESY-67/35) FORWARD PEAK IN π^+ PHOTOPRODUCTION. Buschhorn, G.; Heide, P.; Koetz, U.; Lewis, R. A.; Schmueser, P.; Skronn, H. J. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany). Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Nov. 1967. 6p. Dep.

Previous measurements of single π^+ photoproduction on protons at 2.6 and 5 GeV were extended to small t-values, i.e., (t) = 0.002, 0.0004, and 0.0001 $(GeV/c)^2$. The results demonstrate the absence of a forward dip and therefore disagree with simple Regge pole models. (L.B.S.)

13633 (DESY-67/36) PHOTOPRODUCTION OF π^0 IN THE BACKWARD DIRECTION. Buschhorn, G.; Heide, P.; Koetz, U.; Lewis, R. A.; Schmueser, P.; Skronn, H. J. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)); Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Nov. 1967. 7p. Dep.

The photoproduction of mesons (π^0) in the reaction $\gamma + p \rightarrow \pi^0 + p$ was investigated in the backward direction at photon energies from 0.8 to 5.5 GeV using a bremsstrahlung beam. The structure observed in the cross section implies that resonance contributions, if not dominant, are at least comparable with non-resonant contributions. Only $I = 3/2$ resonances seem to contribute strongly. A shift in the position of the Δ (1920) and the Δ (2420) resonances which is of the order of $\Delta E_\gamma = 100$ MeV is noted. (J.F.P.)

13634 (DESY-67/41) ELECTROPRODUCTION OF ρ^0 MESONS. Blechschmidt, H.; Dowd, J. P.; Elsner, B.; Heinloth, K.; Karow, P.; Rathje, J.; Schmidt, D.; Smith, J. H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)); Kanaris, A.; Wynroe, A. G. (Manchester Univ. (England)). Dec. 1967. 10p. Dep.

A large contribution of multiple meson (π) production was found in a spark chamber experiment. The process $e + p \rightarrow e'^0 + p' + \pi^+ + \pi^-$ at 4.9 GeV was studied. The invariant mass spectrum of the two-meson (π) for the electroproduced events shows a clear peak around the mass of the meson (ρ^0). The differential cross section for the electroproduction of mesons (ρ^0) is shown as a function of the momentum transfer to the nucleon. From the experimental results this differential cross section is predicted to be $(120 \pm 34)(e^{(10\pm5)t})$ μ b/GeV^2. The agreement with experimental results indicates that within the experimental accuracy the contribution of the small longitudinal field component of the virtual photon to the cross section does not cause a significant shift of the cross section behavior in the case of ρ^0 electroproduction. (J.F.P.)

13635 (LAL–1185) MEASUREMENT OF LONGITUDINAL PHOTON CONTRIBUTION IN PION ELECTROPRODUCTION FROM PROTONS. Betourne, C.; Feautrier, C.; Perez-Y-Jorba, J.; Treille, D. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Dec. 1967. 27p. Dep.

A measurement of the pion electroproduction cross section from protons, at a transfer $q^2 = -3.4$ f^{-2} and a πN mass of 1136 MeV, gave the values $\sigma_L = 27.0 \pm 9.2$ μb, $\sigma_T = 81.8 \pm 4.3$ μb, and $\sigma_L/\sigma_T = .33 \pm .13$. It is shown that this result is very sensitive to a correct application of radiative corrections but rather insensitive to the exact analytic expressions used. (auth)

13636 SCATTERING OF MUONS ON PROTONS AT HIGH MOMENTUM TRANSFER. Lederman, L. M. (Columbia Univ., New York). pp 187-95 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

Experiments on the scattering of muons on protons at large momenta transfer were carried out on the strongly focussing synchrotron. Comparison of the results of such experiments with analogous results for electrons could serve as a means of establishing any difference between the charge structure of leptons. However, data based on 500 scattering events with momenta transfer in the 700–1100 MeV/c range indicated that there was no significant difference between μ–p and e–p scattering. (JPRS)

13637 PHOTOGENERATION OF ISOBARS AND η^0 AND OTHER RESULTS. Pless, I. pp 196–213 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

In experiments on photogeneration in a hydrogen bubble chamber, the reaction $\gamma + p \rightarrow p + \pi^+ + \pi^-$ was studied as a function of energy. The formation of several isobars was observed. At approximately 800 MeV, formation of the isobars N^*_{1512} and N^*_{1688} took place. N^+_{1512} decayed into π^- and N^*_{1238}. The distribution of invariant masses $\pi^+\pi^-\pi^0$ generated by the reaction $\gamma + p \rightarrow p\pi^+\pi^-\pi^0$ was determined. In experiments the reaction $\pi^- + p \rightarrow$ neutral particles was investigated at 550–1150 MeV. Formation of $n + \pi^0\gamma+\gamma$ by this reaction was established. The corresponding cross sections of formation of $2\pi^0$, $3\pi^0$, and η^0 were determined. The cross sections for $2\pi^0$ and η^0 passed through a maximum at 900 and 600 MeV, respectively. The reaction $\pi^- + p \rightarrow$ neutral particles as well as $\gamma + p \rightarrow \pi^0 + p$ was also studied. The reaction $\gamma + C \rightarrow C + \eta^+ + \eta^-$, in which muons are generated symmetrically with respect to the γ-beam, is also being studied. (JPRS)

13638 PHOTOGENERATION OF PARTICLES AT HIGH ENERGIES. Fischer, V. (Massachusetts Inst. of Tech., Cambridge). pp 229-40 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

In work carried out by a bubble chamber group, photoproduction of particles by the $\gamma + p$ reaction was studied. Photons from the electron accelerator were employed and a hydrogen bubble chamber was used. Among 3612 events observed, the $\gamma + p$ reaction gave rise to $p + \pi^+ + \pi^-$ in 2281, $p + \pi^+ + \pi^- + \pi^0$ in 699, $n + \pi^+ + \pi^+ + \pi^-$ in 336, $p + \pi^+ + \pi^+ + \pi^- + \pi^-$ in 70, $p + \pi^+ + \pi^+ + \pi^- + \pi^- + \pi^0$ in 51, $n + \pi^+ + \pi^+ + \pi^+ + \pi^- + \pi^-$ in 32, and strange particles in 143 cases. The energy thresholds, cross sections, and angular distributions of individual reactions were determined. The only event in which a Ξ^- hyperon was formed involved the reaction $\gamma + p \rightarrow \Xi^- + K^+ + K^+$, $\Xi^- \rightarrow \Lambda^0 + \pi^+$, $\Lambda^0 \rightarrow p + \pi^-$. (JPRS)

13639 BACKWARD SCATTERING OF POSITRONS AND ELECTRONS ON PROTONS. Bouquet, B.; Benaksas, D.; Grossetete, B.; Jean-Marie, B.; Parrour, G.; Poux, J. P.; Tchapoutian, R. (Ecole Normale Superieure, Orsay, France). Phys. Lett., 26B: 178-80 (Jan. 8, 1968).

The ratio $R = \sigma(e^+ + p)/\sigma(e^- + p)$ of the elastic scattering cross

section detecting the recoil proton at 0° in coincidence with the backward electron or positron was found to be R = 1.036 ± 0.018 at q^2 = 8 fm^{-2}, R = 1.079 ± 0.046 at q^2 = 32 fm^{-2}. (auth)

13640 5- TO 16-GeV SINGLE-π^+ PHOTOPRODUCTION FROM HYDROGEN. Boyarski, A. M.; Bulos, F.; Busza, W.; Diebold, R.; Ecklund, S. D.; Fischer, G. E.; Rees, J. R.; Richter, B. (Stanford Univ., Calif.). Phys. Rev. Lett., 20: 300-3(Feb. 5, 1968). (SLAC-PUB-360).

The differential cross sections for single-π^+ photoproduction from hydrogen were measured over a range of momentum transfers from -2×10^{-4} to -2 $(GeV/c)^2$, and photon energies from 5 to 16 GeV. The differential cross section increases by roughly a factor of 2 as the magnitude of the square of the momentum transfer decreases from 0.02 $(GeV/c)^2$. The cross section falls approximately as exp $(-3|t|)$ at large momentum transfers, with a similar momentum-transfer dependence of the cross section at all photon energies studied. (auth)

13641 ELECTRON–PROTON ELASTIC SCATTERING AT HIGH MOMENTUM TRANSFERS. Coward, D. H. (Stanford Linear Accelerator Center, Calif.); DeStaebler, H.; Early, R. A.; (and others). Phys. Rev. Lett., 20: 292-5(Feb. 5, 1968). (SLAC-PUB-373).

Preliminary results are reported of electron-proton elastic scattering measurements carried out at 4.0 to 17.8 GeV, at scattering angles from 12.5° to 35.1°, and at squared four-momentum transfers from 0.7 to 25.0 $(GeV/c)^2$. The primary electron beam passed through a liquid-hydrogen target and the scattered electrons were momentum analyzed with a magnetic spectrometer utilizing a complex counter system. Values of cross section and G_M/μ are tabulated. In the region of q^2 above 10 $(GeV/c)^2$ the principal feature is the continued decrease of the magnetic form factor approximately as $1/q^4$. (L.B.S.)

Weak

Refer also to abstracts 12604 and 12607.

13642 INTERMEDIATE BOSON. Schwartz, M. pp 79-89 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

The intermediate boson $W^{\pm}$ is a particle that is assumed to play the same role in weak interactions as the photon in electromagnetic and the pion in strong interactions. It is a particle which is most easily understood, although its existence is in doubt and its mass is unknown. Experiments aimed at establishing the existence of the boson were carried out previously. Neither of these experiments has led to a conclusive result, since in both only the lower limit of the mass of the boson was established. The most promising way of investigating bosons in the equipment that is now available is by using strongly interacting particles. Nucleons may be connected with nucleons and mesons over the interactions $W^+ \to p + \bar{n}$ and $W^- \to \bar{p} + n$. One may therefore in general expect that there will be a noticeable cross section for the generation of W which is 10^4–10^5 times smaller than the corresponding cross section for pions. Bosons may be generated by the reaction $\bar{p} + p \to W^- + \pi^+ \to \pi^+ + e^- + \bar{\nu}_e$. Preparations for the study of this reaction are being made. (JPRS)

13643 EXPERIMENTAL STUDY OF THE THREE-PARTICLE LEPTON DECAY OF CHARGED K-MESONS. Mal'tsev, E. I. pp 90-101 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

Work on the 3-particle lepton decay of charged K-mesons was summarized previously. On the basis of the results reported, one may say that the study of the general aspects of interactions of this type has been completed and a detailed quantitative study of $K^{\pm} \to l^{\pm} \pi^0 \nu$ processes has begun. The present status of work in this field is reviewed. Almost 3×10^5 events of the type considered were investigated in all laboratories of the world. The predominant variant of interaction effective in the decay was established, the ratio of frequencies of K^+_{l3} to K^-_{l3} decays estimated, and the ratio of form factors $e = f_-/f_+$ evaluated, which is an important characteristic of the $K^{\pm}_{l3}$ decay. The statistical data collected made it possible to approach closely the quantitative solution of problems pertaining to the energy dependence of form factors, the universality of μ–e, and the nonlocal nature of decay processes, which had been indicated by some experimental results. The most expedient way of conducting future work will be by studying problems in the following sequence: the degree of admixtures to the predominant V-variant in K_{e3}; μ–e universality in K_{e3} and $K_{\mu 3}$; energy dependence of the form factors of K_{e3} and $K_{\mu 3}$; the nonlocal nature of K_{e3}. (JPRS)

13644 MEASUREMENT OF THE ENERGY DEPENDENCE OF THE FORM FACTOR IN $K^0_L \to \pi + e + \nu$ DECAY. Aronson, Samuel H.; Chen, K. Wendell (Princeton Univ., N. J.). Phys. Rev. Lett., 20: 287-91(Feb. 5, 1968).

The pion energy distribution in $K^0_L \to \pi + e + \nu$ decay was measured at the Princeton-Pennsylvania Accelerator using a wide-gap spark-chamber spectrometer. The results are consistent with vector interaction and an energy-independent form factor. The energy-dependence parameter λ is found to be $+0.020 \pm 0.013$. (auth)

13645 DECAY PARAMETERS OF THE Σ^+ HYPERON. Robinson, James Harlie. Madison, Wis., Univ. of Wisconsin, 1967. 89p.

Thesis.

The weak decay parameters, α, β, and γ, of the Σ^+ hyperon in the decay mode $\Sigma^+ \to n\pi^+$ were measured by looking at the angular distribution and polarization of the neutron from the decay. The parameters are defined as: $\alpha = 2\mathrm{Re}\, S^*P/|S|^2 + |P|^2$; $\beta = 2\mathrm{Im}\, S^*P/|S|^2 + |P|^2$; $\gamma = |S|^2 - |P|^2/|S|^2 + |P|^2$; where S and P are the complex amplitudes for S wave and P wave decay respectively. The Σ^+ hyperons were produced in the reaction: $K^- + p \to \Sigma^+ + \pi^-$ using the 25 inch hydrogen bubble chamber exposed to a K^- beam in the momentum range 850–1150 MeV/c which produces Σ^+ hyperons of known polarization. The polarization of the neutrons from the Σ^+ decay was observed using the protons in the bubble chamber as an analyzer. On the basis of 83 np scatters, the following results were determined: $\alpha = -0.16 \pm 0.30$; $\beta = 0.00 \pm 0.80$; $\gamma = -1.00^{+0.00}_{-0.00}$. The value of $\gamma = -1$ shows that the $\Sigma^+ \to n\pi^+$ decay is consistent with pure P wave decay, and resolves an ambiguity that has existed for many years in the $|\Delta T| = \frac{1}{2}$ rule for Σ decays. (Disser. Abstr.)

Strong (Baryon-Induced)

13646 (UCRL-17408(Rev.)) NUCLEON–NUCLEON SCATTERING EXPERIMENTS AT INTERMEDIATE ENERGIES IN BERKELEY. Cheng, David (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1967. Contract W-7405-eng-48. 24p. (CONF-670302-8). Dep. CFSTI.

From American Physical Society, Nucleon-Nucleon Interaction Conference, Gainesville, Fla.

Various N + N experiments are described. The energies studied range from about 310 to 740 MeV. The polarization parameter is the primary object of study, and results on polarization and angular distributions are shown for the various experiments. (J.F.P.)

13647 SEARCH FOR NEW HEAVY PARTICLES. Dorfan, D. E.; Eades, J.; Lederman, L. M.; Lee, W.; Ting, C. C. pp 570-90 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

A search was made for new metastable particles with a mass of 3 to 7 BeV in experiments in which Be and Fe nuclei were bombarded with 30 BeV protons. Such particles could not be detected. Generation of antideuterons in experiments in which the Be target was bombarded with 30 BeV protons and of antiprotons on moving intranuclear nucleons in experiments in which Cu was bombarded with protons (p + Cu $\to \bar{p}$ + residual nucleus) was established. (JPRS)

13648 NEW PHENOMENA PRODUCED BY HIGH AND SUPERHIGH ENERGY COSMIC RADIATION UNDERGROUND. Vernov, S. N.; Khristiansen, G. B.; Nechin, Yu. A.; Khrenov, B. A.; Vedeneev, O. V.; Fomin, Yu. A. pp 591-608 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

In 1964–65 a study of the penetrating component of cosmic radiation generated by primary particles of high and superhigh energy (10^{12}–10^{15} eV) was conducted. Measurements were made in a subterranean installation at a depth of 40 m. The apparatus consisted of 240 ionization chambers and approximately 2000 Geiger–Mueller counters. The results obtained could not be interpreted on the basis of current ideas pertaining to the nature of cosmic radiation underground and its nuclear interactions. They indicated that at not very great depths underground (at a depth of the order of tens of meters) and sufficiently high energies (>10^{11} eV) of the particles considered, a relatively small number of particles (X-particles) other than μ-mesons must be present, the shower-forming capacity of which is significantly greater than that of μ-mesons. The mass of X-particles may be assumed to be greater than 5 BeV. (JPRS)

13649 DIFFERENTIAL CROSS SECTIONS IN PROTON–PROTON SCATTERING AT 52,34 MeV. Sanada, J. (Tokyo Univ.); Kuriyama, K.; Takeuchi, Y.; (and others). Progr. Theor. Phys. (Kyoto), 38: 1202-3(Nov. 1967).

Differential cross sections for proton-proton scattering at 52.34 MeV are tabulated. The measurements were performed using a large scattering chamber of sliding cylinder type filled with hydrogen gas, and NaI(Tl) scintillation detectors for detection of the scattered protons. (L.B.S.)

13650 REANALYSIS OF THE PROTON–PROTON SCATTERING DATA AT 50 MeV. Hoshizaki, Norio (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 38: 1203-4(Nov. 1967).

Proton-proton phase shifts at 50 MeV are tabulated based on new scattering data of Sanada et al. (Prog. Theor. Phys., 38: No. 5, 1202(1967)). The anomaly that appeared in earlier analyses was found to disappear. (L.B.S.)

13651 THE U(θ) ASYMMETRY IN ELASTIC 635 MeV pp-SCATTERING. Zul'karneev, R. Ya.; Kiselev, V. S.; Nadezhdin, V. S.; Satarov, V. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 995-7(Nov. 1967). (In Russian).

The results of the U(θ) asymmetry measurements of elastic pp-scattering are described as being completely due to the totally polarized beam. The measurements were performed at 635 MeV in the angle range from 28 to 90° (cms). Earlier pp-scattering phase shifts were improved by using both these results and those of other experiments. In searching for solutions beginning from random values three solutions with $l_{max} = 5$ and two solutions with $l_{max} = 4$ were obtained. Thus, in the energy range analyzed no evidence for the existence of a single phase-shift solution was obtained. (auth)

Strong (Meson-Induced)

Refer also to abstracts 13645 and 14034.

13652 (COO–1195-111) THE REACTION $K^-p \rightarrow K^-\pi^+\pi^-p$ AT 4.1 AND 5.5 GeV/c. Kim, S.; Park, J. C.; Chandler, G.; Ascoli, G.; Goldwasser, E. L. (Illinois Univ., Urbana. Dept. of Physics). Dec. 22, 1967. Contract AT(11-1)-1195. 29p. (CONF-671122-3). Dep. CFSTI.

From 3rd Topical Conference on Resonant Particles, Athens, Ohio.

The reaction $K^- + p \rightarrow K^- + \pi^+ + \pi^- + p$ at 4.1 and 5.5 GeV/c in a hydrogen bubble chamber was studied. It was observed that this reaction is dominated by $\overline{K}^*$ (890) and N^{*++} (1236) production at both energies. A summary of cross sections for different resonance channels lead to the studied reactions is given. A study of the absorptive peripheral model as applied to the reaction $K^- + p \rightarrow \overline{K}^{*0} + N^{*0}$ is made, and an account of the $K^{*0}\pi^-$ system is given. (J.F.P.)

13653 (RPP/H-28) PARTICLE PRODUCTION FROM COPPER AND URANIUM TARGETS BY 8 GeV/c PROTONS. Davies, J. D. (Birmingham Univ. (England); Carter, A. A. (Cambridge Univ. (England). Cavendish Lab.); Bugg, D. V.; (and others) (Rutherford High Energy Lab., Chilton (England)). 1967. 23p. Dep. CFSTI. UK.

A detailed study was made of the production of K^- and π^- mesons at 690, 745, and 935 MeV/c by 8 GeV/c protons incident on copper and uranium targets. Yields are reported as a function of target length over the range of production angles 0° to 15°. The maximum yield for thick targets occurs at about 7°, and it is shown that this may be understood in terms of re-absorption of secondaries within the target. The ratios K^-/π^-, p/π^+, p/π^- were also measured within the momentum range 600 to 2600 MeV/c. The studies reported emanate from Cambridge and Birmingham Universities, and the Rutherford High Energy Laboratory. (auth)

13654 (RPP/H-31) KAON–NUCLEON TOTAL CROSS SECTIONS FROM 0.6 TO 2.65 GeV/c. Bugg, D. V. (Rutherford High Energy Lab., Chilton (England); Davies, J. D. (Birmingham Univ. (England); Carter, A. A.; (and others) (Cambridge Univ. (England). Cavendish Lab.). 1967. 35p. Dep. CFSTI. UK.

Total cross sections of K^+ and K^- mesons on protons and deuterons were measured in a transmission experiment over the range of laboratory momentum 0.6 to 2.65 BeV/c. Measurements were made on K^- at 58 momenta at intervals of 25 to 50 MeV/c; the experimental accuracy was better than 1% above 700 MeV/c, and the momentum resolution of the beam was ±0.6%. Structure was observed in the total cross sections suggesting or confirming Y_1^* resonances at masses of 1665, 1768, 1905, 2020, 2250, and 2455 MeV/c^2 and Y_0^* resonances at masses of 1695, 1819, 1870, 2100, and 2340 MeV/c^2. The K^+ measurements were less extensive, and were concentrated in the momentum range below 1.5 GeV/c; the experimental errors were typically ±0.2 mb. Structure previously reported in the K^+p and K^+d total cross sections near a laboratory momentum of 1.2 GeV/c was confirmed. Total cross sections of K^+ and K^- on carbon were measured at a number of momenta with an accuracy of about ±2%. The studies described emanate from the Rutherford High Energy Laboratory and the Universities of Cambridge and Birmingham. (auth)

13655 (UCRL–17984) RESONANCE PRODUCTION IN π^+p INTERACTIONS BETWEEN 3 AND 4 GeV/c. Gidal, G.; Brown, D.; Birge, R. W.; Bacastow, R.; Fung, S. Y.; Jackson, W.; Pu, R. T. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 26, 1967. Contract W-7405-eng-48. 18p. (CONF-671122-2). Dep. CFSTI.

From 3rd Topical Conference on Resonant Particles, Athens, Ohio.

Two experiments from an exposure of a hydrogen bubble chamber to mesons (π^+) 2.95 to 4.1 GeV/c are reported. The first is observation of B enhancement using 9400 events of the type $\pi^+ + p \rightarrow \pi^+ + p + \pi^+ + \pi^- + \pi^0$. The second is the decay of $N^* \rightarrow \Delta^{2+} + \pi^-$ from 7800 events of the type $\pi^+ + p \rightarrow \pi^+ + p + \pi^+ + \pi^-$. The $\omega\pi$ mass spectrum showing the B enhancement of about 150 events above background near 1230 MeV is presented. The distribution of $M(\Delta^{2+}\pi^-)$ for all events among five energies is shown. (J.F.P.)

13656 NEW METHOD FOR THE INVESTIGATION OF UNSTABLE PARTICLES: SPECTROSCOPY OF BOSONS BY THE MISSING-MASS METHOD. Maglic, B. (CERN, Geneva). pp 273-94 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

The new CERN missing-mass spectrometer comprises spark chambers with sound recording, a system for measuring the time of flight, amplitude analyzers, and hodoscopic counters. It has a pion and a proton line of measurement. The mass spectra obtained on it show the peaks of known δ- and A_2 meson resonances with a statistical precision that is an order of magnitude better than that reached in experiments conducted hitherto. A new boson δ with M = 962 MeV, $0 < \Gamma < 5$ MeV, and I equal to 1 or 2 was detected. The data obtained on it agree with the assumption of a decay process according to $\delta \rightarrow \eta\pi^-\pi^0$. If δ is a charged X^0 meson, its quantum numbers must be I = 1, J = 1+. A weak peak at M = 1080 MeV was observed. Although M = 1080 MeV corresponded to the value for the known A_1 meson, the peak had a width of $0 < \Gamma < 5$ MeV vs $\Gamma \geq 80$ MeV for A_1 in previous experiments. A new resonance with a triple standard deflection, M = 1150 MeV, and $0 < \Gamma < 5$ MeV was also observed, which could be ascribed to a boson. The detection of this boson and the boson δ may indicate that the A_1 meson resonance with a wide peak observed in previous work actually consisted of two or more resonances that were not resolved. (JPRS)

13657 RESONANCES IN MULTIPION SYSTEMS. Guiragossian, Z. G. T. (Stanford Linear Accelerator Center, Calif.). pp 295-320 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

On the basis of experimental data obtained on the hydrogen bubble chamber by using bevatron π^- beams with momenta of 3.9 and 4.16 BeV/c, resonances in the systems $\pi\pi$, $\rho\pi$, $\omega\pi$, and $\eta\pi$ were studied. Two- and four-track events corresponding to the reactions $\pi^-p \rightarrow p\pi^-\pi^0$, $\pi^-p \rightarrow n\pi^+\pi^-$, $\pi^-p \rightarrow p\pi^+\pi_1^-\pi_2^-$, and $\pi^-p \rightarrow p\pi^+\pi^0\pi_1^-\pi_2^-$ were selected and measured by methods involving semi-automatic scanning and the use of computers. Few ϵ^0 mesons were detected because of the decay of these mesons into $\pi^+\pi^-$ and $\pi^0\pi^0$. The formation of A_1, A_2, and B mesons in the two 4-track reactions and their decay were investigated. The connection between the formation of ρ^0 mesons and the A_1 and A_2 resonances was determined and the characteristics of the ω^0, π resonance (B meson) were studied. (JPRS)

13658 SEARCH FOR HYPERON RESONANCES WITH SPARK CHAMBERS. Meyer-Berkhout, U. pp 321-4 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

The missing mass of hyperons Y^- with an isotopic spin of 1 or 2 was determined in the reactions $\pi^- + p \rightarrow K^+ + Y^-$. An experimental arrangement in which a liquid hydrogen target was bombarded with π^- mesons in the 1.0 to 2.75 BeV/c range was used. Five spark chambers were employed. The missing mass spectrum was determined on the basis of the production angle and momentum of K^+ mesons. The Σ^- hyperon peak was at a π^- momentum of 1075 MeV/c, that for formation of Y^* (Y_1^*) at 1385 MeV. After a decrease in the yield of K^+ at energies above the Y_1^* resonance, there was a rapid increase at a missing mass value of 1430 MeV. Above 1500 MeV the yield of K^+ increased again by reason of nonresonance end states and also apparently because of the reactions $\pi^- + p \rightarrow \Lambda, \Sigma, Y_1^* + K^+$; $K^+ \rightarrow K^+ + \pi^-$. After peaks at 1660 and 1765 MeV there were decreases in the yield of K^+, followed by an increase at 1900 MeV. Additional studies are needed for an understanding of this range. (JPRS)

13659 BACKWARD ELASTIC SCATTERING OF π^- MESONS ON NEUTRONS. Galaktionov, Yu. V. pp 535-40 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

The backward elastic scattering of pions in the reaction $\pi^- + n \rightarrow \pi^- + n$ was studied at momenta in the 1.38 to 4.05 BeV/c range. Events in a cylindrical spark chamber containing the target (D_2O or H_2O) were recorded by measurement of γ-quanta emitted in the π^0 decay. Neutrons scattered forwards were also recorded. The cross sections $\bar{\sigma}_n = \bar{\sigma}_{D_2O} - \bar{\sigma}_{H_2O}$ in relation to the energy were determined. The cross section on neutrons of ^{16}O was also determined. The values of $\bar{\sigma}_{H_2O}/\bar{\sigma}_{D_2O}$ for different energies were close to each other. An irregularity on the cross section of the pion scattering–momentum curve indicated the possibility of $\Delta(2360)$ resonance at 2 to 3 BeV/c. A cross section peak at $-1 < \cos\theta < -0.95$ was observed, which was 3.5 times narrower than the forward diffraction peak. The cross section of the reaction at 160 to 180° and 4 BeV/c was 23 ± 9 μ barn/steradian, which agreed with the value of 26 ± 6 μ barn/steradian obtained previously in a study of backward π^+n elastic scattering at these angles and 4 BeV/c. (JPRS)

13660 SCATTERING OF HIGH-ENERGY PARTICLES AT HIGH MOMENTUM TRANSFER. Lyubimov, A. L. pp 556-69 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

The relation formulated by J. Orear (Phys. Lett., 13: 190(1964)), according to which differential cross sections of elastic p-p scattering depend on the angle and exponentially on the $p_\perp$ transverse momentum, described accurately the data on elastic p-p scattering at angles of 30 to 90° and energies of 10 to 31 BeV. It also defined the distribution according to transverse momenta of secondary particles formed in p-p interactions at 25 to 10^6 BeV and applied in a modified form (with the momentum transfer substituted for the transverse momentum) to ep scattering at high values of the transmitted momentum. Orear's relation was checked mainly on p-p interactions, in which scattering at angles >90° cannot take place because of the identity of the particles. If the exponential relation also applies to π,p scattering, a peak at 180° in the angular distribution of backward scattering must exist. This peak was actually observed for both π^+ and π^- mesons scattered backwards on protons. (JPRS)

13661 PION–NUCLEON SCATTERING AT MOMENTA OF 875 TO 1850 MeV/c. Duke, P. pp 638-48 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

Experiments on the scattering of π^+ and π^- mesons on protons were conducted on the 7 BeV proton-synchrotron to establish the parities of the resonances N^*_η (1688) and N^*_ξ (1920). The data obtained indicated that there was interference of two resonances with the same parity, i.e., of F_η and F_ξ. On the basis of the results obtained, the quantum numbers $5/2^+$ and $7/2^+$ can apparently be assigned to N^*_η (1688) and N^*_ξ (1920), respectively. (JPRS)

13662 SEARCH FOR A CHARGED MESON IN THE MASS REGION OF 960 MeV. Barbaro-Giltieri, Angela; Matison, Maxine; Rittenberg, Alan; Shively, Frank T. (Univ. of California, Berkeley). Phys. Rev. Lett., 20: 349-52(Feb. 12, 1968).

A experiment was performed using a deuterium-filled bubble chamber exposed to a K^- beam at 2.11 and 2.65 GeV/c; the reaction $K^-d \rightarrow \Lambda X^-(\rho_4)$ was studied, where X^- is a negative meson decaying into two to five pions or pions plus a γ. The results rule out the possibility that δ and η' are the same particle, and set some upper limit on the cross section for production of the δ in $K^- + \eta \rightarrow \Lambda + \delta^-$ with subsequent decay of the δ into various states. (L.B.S.)

13663 THE PROBLEM ON COHERENT INTERACTIONS OF π MESONS WITH EMULSION NUCLEI AT 17 BeV. Vinitskii, A. Kh.; Strel'tsov, I. S.; Takibaev, Zh. S.; Chasnikov, I. Ya. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 90-3(Mar.–Apr. 1967). (In Russian).

Coherent events of the following type were studied: $\pi^- + A \rightarrow \pi^- + \pi^- + \pi^+ + A'$. Here A and A' are the target nucleus before and after the interaction. An Ilford G-5 nuclear emulsion was irradiated on the CERN accelerator with a beam of π^--mesons having a momentum of 17 GeV/c. Primary particle tracks were examined, and 126 three-ray interactions were found along 1632 m of primary tracks. The emission angles of the secondary particles were measured. A complete analysis of the events which was based on an exact measurement of all the kinematic characteristics of the secondary particles and their identification gave a total of 19 coherent interactions with the heavy emulsion nuclei of Ag and Br. The average mean free path was 86^{+17}_{-13}m. (TTT)

13664 DOUBLE EMISSION OF HYPERFRAGMENTS IN HIGH ENERGY K^- MESON INTERACTIONS WITH EMULSION NUCLEI. Bechdolff, A.; Baumann, G.; Gerber, J. P.; Cuer, P. (Centre de Recherches Nucleaires, Strasbourg). Phys. Lett., 26B: 174-7 (Jan. 8, 1968).

Four events involving a hyperfragment pair are reported. The results are compatible with the existence of an intermediate Ξ-hyperfragment. (auth)

13665 MEASUREMENT OF π^-p SCATTERING NEAR 180° IN 4 TO 7 GeV/c π^--MESON BEAM. Kulakov, B. A.; Mal'tsev, E. I.; Filippov, P. I.; Tsislyak, O. N.; Tsyganov, E. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1010-14 (Nov. 1967). (In Russian).

Measurements of π^--p-scattering cross sections by 180° are given. The measurements are performed by an electronic method using filmless wire spark chambers. To select the events of elastic π^--p-scattering, the recoil proton momenta were measured by means of magnetic spectrometer. Geometric efficiency of the device was calculated using the Monte Carlo method. $1,4-(10)^9$ primary π^--mesons were passed through the device. The values of cross sections for π^--momenta within 4 + 7 GeV/c were obtained. (auth)

13666 ZERO-DEGREE PRODUCTION OF HIGH-MOMENTUM π^+ MESONS BY π^- MESONS INCIDENT ON NUCLEI. Lundy, R. A. (Argonne National Lab., Ill); Pless, I. A.; Rust, D. R.; Yovanovitch, D. D.; Kistiakowsky, Vera. Phys. Rev. Lett., 20: 283-7(Feb. 5, 1968).

A study was made of π^+ production at 0° by 2- to 6-BeV/c π^- incident on beryllium, carbon, copper, lead, and polyethylene. Several possible mechanisms are examined; the results seem to favor the mechanisms $\pi^- + p \rightarrow \rho^0 + n$, $\rho^0 \rightarrow \pi^+ + \pi^-$ and $\pi^- + p \rightarrow f^0 + n$, $f^0 \rightarrow \pi^+ + \pi^-$, but the possibility of the mechanism $\pi^- + p \rightarrow N^{*-} + \pi^+$ is not ruled out. (L.B.S.)

13667 MEASUREMENTS OF POLARIZATION IN $\pi^-p \rightarrow \pi^0n$ and $\pi^-p \rightarrow \eta$. Drobnis, D. D.; Lales, J.; Lamb, R. C.; Lundy, R. A.; Moretti, A.; Niemann, R. C.; Novey, T. B.; Simanton, J.; Yokosawa, A.; Yovanovitch, D. D. (Argonne National Lab., Ill.). Phys. Rev. Lett., 20: 274-8(Feb. 5, 1968).

Measurements were carried out at the Argonne ZGS of the polarization in the charge-exchange reaction $\pi^+ + p \rightarrow \pi^0 + n$ at 20 to 5.0 GeV/c, and in the reaction $\pi^- + p \rightarrow \eta^0 + n$ at 3.2 to 5.0 GeV/c. In this region a simple Regge-pole model leads to a prediction of nonzero polarization when combined with known direct-channel resonances. Details are presented of the experimental arrangements and measurements. Polarization data are tabulated for various momentum transfer intervals at 2.07, 2.50, 2.72, 3.20, 3.46, and 5.00 GeV/c. The average polarization are found to be positive throughout the entire momentum range. (L.B.S.)

13668 THE ASYMMETRY OF THE ρ^0 MESON. Huwe, Darrell O. (Ohio Univ., Athens). pp 103-22 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

Two-prong events from an exposure of the hydrogen bubble chamber to mesons (π^-) at 2.36 GeV/c laboratory momentum were studied. About 14,000 events were measured. Histograms of the four momentum transfer squared from proton to neutron, the meson (π)–meson (π) invariant mass distribution, and angular distributions are shown. (J.F.P.)

13669 THE REACTION $K^- + n \rightarrow \Lambda + \pi^-$ BETWEEN 1660 AND 1900 MeV CENTER-OF-MASS ENERGY. Kernan, Anne; Ely, Robert P. Jr.; Kalmus, George E.; Smart, Wesley M. (Univ. of California, Berkeley). pp 133-46 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

There were 23,580 pictures of $K^- + d \rightarrow \Lambda + \pi^- + p$, $\Lambda \rightarrow \pi^- + p$ events taken at 815 to 1110 MeV/c in the bubble chamber. The measured angular distribution of the meson (π) and the lambda polarization in the reaction $K^- + n \rightarrow \Sigma^0 + \pi^-$ are shown. The parameters and quantum numbers of $\Sigma(1660)$, $\Sigma(1770)$, $\Sigma(1910)$, and $\Sigma(2035)$ are listed. (J.F.P.)

13670 LOW ENERGY K^0_2–PROTON INTERACTIONS. Oren, Yona; Kadyk, John A. (Univ. of California, Berkeley). pp 155-70 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

A study with high statistics of K^0_2 interactions in a hydrogen bubble chamber is reported. This experiment was particularly oriented toward the observation of K^0_1 of which the mean momentum is about 300 MeV/c. Angular and momentum distributions are shown. The data are found to be in good agreement with the I = 1 scatter-

ing length. The set of solutions not allowing the Dalitz–Tuan interpretation are unambiguously ruled out. Finally, a substantial amount of P-wave is found to be present in the $\Lambda^0 + \pi^+$ channel, even at the lowest energies, which can be attributed to the presence of Σ (1385). (J.F.P.)

13671 STUDY OF THE S-WAVE $\pi-\pi$ INTERACTION IN K^+_{e4} DECAY. Murphy, Thornton C. (Univ. of Michigan, Ann Arbor). pp 171-94 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

Some evidence that the s-wave phase shift for the $\pi + \pi$ is positive or possibly zero in the dipion mass region below 400 MeV is reviewed. There were 69 examples of the decay mode $K^+ \rightarrow \pi^+ + \pi^- + e^+ + \nu$, the angular correlations and dipion mass spectrum were found to fit an effective range model with a scattering length in the range 0 to $4\lambda_\pi$. The credibility of this result is examined. For this purpose the validity of the experimental data are reviewed, and the theoretical assumptions made are discussed. (J.F.P.)

13672 STUDY OF THE REACTION $\pi^+p \rightarrow \Sigma^+\pi K$ AT 3.2 GeV/C. Reeder, Don David. Madison, Wis., Univ. of Wisconsin, 1966. 123p.

Thesis.

A separated beam of π^+ mesons was directed into the 20 inch BNL hydrogen bubble chamber. From an exposure of 110,000 pictures 317 examples of the reaction $\pi^+p \rightarrow \Sigma\pi K$ were identified. Kinematic fitting and ionization information were used to separate the reaction. The partial cross section was measured to be: $\sigma(\pi^+p \rightarrow \Sigma^+K^0\pi^+) = 94.0 \pm 15.$ μb; $(\pi^+p \rightarrow \Sigma^+K^+\pi^0) = 100.0 \pm 20$ μb. This final state is dominated by production of the K* resonance. The cross section for K* production is; $\sigma(\pi^+p \rightarrow \Sigma^+K^{*+}) = 112. \pm 23.$ μb. In the sample of events in which the K^0_1 decay was observed the parameters of the K* were measured with the results: $M^* = 897 \pm 3.4$ MeV and $\Gamma = 47 \pm 7$ MeV. The fraction of K* production in the $\Sigma^+K^+\pi^0$ charge state, was 40 ± 9 per cent and in the $\Sigma^+K^0\pi^+$, 79 ± 5 per cent. K* production is peripheral. A spin alignment of the K* is observed in the decay angular distributions. This is interpreted as evidence for predominantly K* exchange. The density matrix elements in K* decay were measured with the results: $\rho_{0,0} = 0.10 \pm .07$, $\rho_{1,-1} = .30 \pm .02$ and $\rho_{1,0} = 0.0 \pm .05$. The polarization of the sigma hyperon was measured and found to be .12 ± 14. The results are compared to the peripheral model in its various formulations. Although qualitative agreement is observed, the magnitude and shape of momentum transfer distribution are in quantitative disagreement with the absorption model and the peripheral model with form factors. The unknown vector meson coupling constants make the quantitative comparison doubtful and determination of these coupling constants is impossible because of small statistics and the questionable validity of the current formulations of the peripheral model with absorption. (Disser. Abstr.)

13673 EXPERIMENTAL DETERMINATION OF THE KΣN PARITY USING A POLARIZED PROTON TARGET. Dieterle, Byron Dale. Berkeley, Calif., Univ. of California, 1967. 53p.

Thesis.

The KΣN parity was determined using the reaction $\pi^+p \rightarrow K^+\Sigma^+$. A crystal containing polarized protons was used as the target. The counting rates for events produced from protons polarized parallel and antiparallel to $\vec{P}_\Sigma$, where $\vec{P}_\Sigma$ is the polarization of Σ's produced from unpolarized protons and was previously measured were compared. A higher counting rate was obtained for events for which the protons were polarized parallel to $\vec{P}_\Sigma$, which means that the production amplitude is a scalar. As a scalar amplitude connects states of the same parity, the KΣN parity is obtained. $I_{K\Sigma N} = I_{\pi p} = -1$. This result depends only on the assumptions of spin ½ for the sigma and parity conservation in the reaction. Error estimates give 80% probability that the result agrees with an assignment $I_{K\Sigma N} = -1$. The probability for agreement with $I_{K\Sigma N} = +1$ is 2%. The result agrees with the usual expectations (as from SU_3) and with a previous experimental determination. (auth)

13674 INVESTIGATION OF THE $(Y^*_1)^0$ PION-HYPERON RESONANCE IN (1.5 GeV/C)$\pi-P$ INTERACTIONS. Curtis, Lorenzo Jan. Ann Arbor, Mich., Univ. of Michigan, 1963. 112p.

Thesis.

This study was undertaken to investigate the uncharged mode of the Y^*_1 elementary particle resonance which was observed to occur between the pi meson and the lambda hyperon at a cm energy of around 1385 MeV. Bubble chamber studies have indicated that this resonance has a width of around 50 MeV and a spin ≥3/2. Most of these studies were made using reactions which produced only the charged modes, and most were obtained under conditions in which the resonant state possessed considerable momentum in its production cm. The results to be presented were obtained by means of negatively charged pi mesons of momentum 1.508 BeV/c which interacted with protons in a liquid hydrogen target. The interaction produced the lambda hyperon and pi meson, in association with a K meson. This incident pion momentum was very near threshold for the reaction. The interaction was detected with a thin-plate spark chamber, counter-controlled to detect only neutral modes. Stereo photographs were taken of the particle tracks. These tracks were then measured manually, and the data were kinematically analyzed by means of an IBM 7090 computer. There were 127 events of this type obtained. Paired invariant mass distributions of the final states indicated that the reaction was dominated by production of the $(Y^*_1)^0$ pion-hyperon resonance, with mass 1381 ± 4 MeV, and width 30 ± 9 MeV. The differential cross section for production of the $(Y^*_1)^0$ is (6.3 ± 0.9) [1 + (0.15 ± 0.27) $\cos\theta - (0.35 \pm 0.38)$ $\cos^2\theta$] μb/sr; the total production cross section is (70 ± 11) μb. Decay distributions of this resonance, assuming S and P wave production, are consistent with spin 3/2, favoring it over spin 5/2 with a likelihood ratio of 10/1. (Disser. Abstr.)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 13629.

13675 ZERO-POINT KINETIC ENERGY IN RELATIVISTIC FERMION GASES. Horvath, J. I. (Atilla Jozsef Univ., Szeged, Hungary). Acta Phys. Chem., 13: 3-19(1967).

To explain the internal structure of physical fields and elementary particles, i.e., to understand the symmetry properties recently proposed in high-energy physics, the relativistic phase-space is considered as a geometric background for physical processes. The concept of this proposal was suggested by the analogy between the geometry of Yukawa's bilocal theory of fields and the relativistic phase-space formalism, as well as by the arguments in favor of the belief that the phase space formalism would be adequate to represent the dynamic symmetries of elementary physics in a natural way. Investigation of the geometric structure of the relativistic phase-space was also suggested, independently of the arguments mentioned above, by the increasing interest in the relativistic generalizations of kinetic and statistic theories of gases on the basis of plasma physics and modern astrophysical theories. After a definition of the relativistic phase-space volume, the zero point kinetic energy of perfect fermion gases was calculated in Riemannian space to resolve problems of neutrino astrophysics. (BBB)

13676 FLUCTUATION OF SPACE–TIME AND ELEMENTARY PARTICLES. II. Takano, Yoshiro (Yokohama National Univ., Japan). Progr. Theor. Phys. (Kyoto), 38: 1186-7(Nov. 1967).

The general considerations on space-time fluctuations and elementary particles discussed previously are illustrated assuming that the fluctuation of space-time is the three-dimensional harmonic oscillation. (L.B.S.)

13677 FLUCTUATION OF SPACE–TIME AND ELEMENTARY PARTICLES. I. Takano, Yoshiro (Yokohama National Univ., Japan). Progr. Theor. Phys. (Kyoto), 38: 1185-6(Nov. 1967).

An attempt is made to connect the divergence difficulty with the unified description of elementary particles on the basis of the hypothesis of fluctuating space-time. The space-time fluctuation is represented by the probability distribution function, and its probability amplitude characterizes the internal freedom of elementary particles. (L.B.S.)

13678 CONSISTENCY PROBLEMS IN AN EXTENDED SCHWINGER–THIRRING–WESS MODEL. Haberler, P. L. F. (IAEA, Trieste, Italy). Acta Phys. Austr., 25: 350-62(Dec. 1967).

The solution of a Thirring–Wess model describing the interaction of massless fermions with massive vector particles is extended to the case of fermions with a finite mass. Special care is given to the definition of the conserved current by which the two fields are coupled to each other and all consistency requirements are checked. Also, the contribution to the Green functions is calculated up to the fourth order in coupling constant. (auth)

13679 LECTURES IN THEORETICAL PHYSICS. VOLUME IX B. HIGH ENERGY AND PARTICLE PHYSICS. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967. 445p. $19.50 Hardbound, $8.95 Paperbound.

Separate abstracts were prepared for the 26 lectures. (J.F.P.)

For abstracts of individual lectures see: 13668–13671, 13680–

13682, 13706, 13707, 13741, 13742, 13766, 13767, 13780, 13801–13805, 13819, 13828, 13829, 13846, 13847, 13872, and 13873.

13680 THRESHOLD BEHAVIOR OF PARTIAL WAVE AMPLITUDES IN QUANTUM FIELD THEORY. Uretsky, J. L. (Argonne National Lab., Ill.). pp 55-67 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

Since there is no assurance that the threshold behavior tan $\delta_l \sim k^{2l+1}$ of elastic scattering phase shifts can describe the interactions of nuclear and subnuclear particles, axiomatic field theory is used to determine whether this equation can follow more general principles. The starting point for the discussion is the Haag–Ruelle scattering theory, and the axiomatic framework is the Wightman field theory of a neutral scalar field. (J.F.P.)

13681 GENERALIZED WARD–TAKAHASHI IDENTITIES AND CURRENT ALGEBRAS. Raman, K. (Syracuse Univ., N. Y.). pp 393-424 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

A unified derivation of some consequences of current algebras generated by conserved and partially conserved currents is discussed. This discussion includes the generalization of the Ward–Takahashi identities to the nonabelian gage groups of interest in strong interactions and the resulting relations for physical amplitudes. The application to meson–baryon scattering is discussed in detail, and questions arising in off-mass-shell limits are examined. As a further illustration, some low-energy theorems for soft-meson production by photons and neutrinos are written. Finally, questions concerning the choice of basic commutation relations are briefly discussed. (J.F.P.)

13682 PHASE SPACE MANIFOLDS. Dreitlein, Joseph (Univ. of Colorado, Boulder). pp 425-31 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

Noise arising from a purely random dynamics is considered. A straightforward physical method of finding a parametrization of phase space, the range of invariant variables and the a priori weighting of phase space is given. Such information can be used in carrying out a complete analysis of the signals from a multiparticle final state. (J.F.P.)

13683 LETNYAYA SHKOLA PO PROBLEMAM TEORII ELEMENTARNYKH CHASTITS, KYAYARIKU, USSR, AVGUST 1965. TOM IV. (Summer School Sessions on Elementary Particle Physics, Kaariku, USSR, August 1965. Volume 4). Palgi, L.; Yiglane, Kh. (eds.). Tartu, Instituut Fiziki Astronomii Estonskoi SSR, 1966. 74p.

Seven lectures are included; separate abstracts are prepared for each. (L.B.S.)

For abstracts of individual papers see: 13684, 13705, 13724, 13725, 13748, 13843, and 13858.

13684 A DECOMPOSITION OF THE KEMMER–DUFFIN WAVE FUNCTION. Ainsaar, A. A. pp 45-8 of Letnyaya Shkola po Problemam Teorii Elementarnykh Chastits, Kaariku, USSR, Avgust 1965. Tom IV. Palgi, L.; Yiglane, Kh. (eds.). Tartu, Instituut Fiziki Astronomii Estonskoi SSR, 1966. (In Russian).

The equation of a particle with spin zero is a second-order differential equation which can be put in the form of a first-order equation on determining the five-component wave function. These equations then acquire a form analogous to the Dirac equation. The algebraic properties of the matrices remain unchanged. The problem is to form terms of the Klein-Gordon type from any representation of a Kemmer-Duffine wave function. The separation of the vector potential and field tensor components of the wave function is carried out by the use of projection operators. (TTT)

13685 LECTURES IN THEORETICAL PHYSICS. VOLUME IX A. MATHEMATICAL METHODS OF THEORETICAL PHYSICS. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967. 407p. $19.50 Hardbound, $8.95 Paper.

There were eight lectures presented. A separate abstract was prepared for each lecture. (J.F.P.)

For abstracts of individual lectures see: 13236, 13686, 13687, 13798, 13799, and 13840–13842.

13686 ENVELOPING ALGEBRAS OF LIE ALGEBRAS. Dreitlein, Joseph (Univ. of Colorado, Boulder). pp 173-86 of Lectures in Theoretical Physics. Vol. IX A. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

An attempt is made to find the complete set of consequences of the operator calculus implied by current commutators. The beginning of such a program and the study of the enveloping algebra of the Lie algebra of currents are presented. One result is a systematization of the study of tensor operators of various ranks including the zero-order tensors (invariants). (J.F.P.)

13687 RIGGED HILBERT SPACE AND MATHEMATICAL DESCRIPTION OF PHYSICAL SYSTEMS. Boehm, Arno (Syracuse Univ., N. Y.). pp 255-317 of Lectures in Theoretical Physics. Vol. IX A. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

The mathematical structure of rigged Hilbert spaces is constructed and its application to some mathematical problems is described. The application of rigged Hilbert spaces for the description of physical systems is studied in simple models, and its usefulness in connection with some problems of the present algebraic approach to elementary particles physics is shown. (J.F.P.)

13688 TOPICS IN SEVERAL PARTICLE DYNAMICS. Watson, K. M.; Nuttall, J.; Chisholm, J. S. R. Holden-Day Advanced Physics Monographs. San Francisco, Holden-Day, Inc., 1967. 130p. $7.50.

Several techniques for treating three-particle systems that have proved useful are reviewed. Some mathematical aspects of the type of integral equations that arise in scattering theory are surveyed. Some aspects of the two-body problem, and the case of multi-channel two-particle systems are treated. The rearrangement of the integral equations for scattering in order to apply standard methods is studied, and the three-body problem for factorable two-body potentials, where significant simplifications ensue, is covered. Also several applications of variational principles are described for the problems discussed. (J.F.P.)

13689 VOPROSY FIZIKI ELEMENTARNYKH CHASTITS. (Problems of Elementary Particle Physics). Alikhanyan, A. I. (ed.). Pyataya Sessiya Vesennei Shkoly Teoreticheskoi i Eksperimental'noi Fiziki, Erevan, 18–28 Maya 1965. (Fifth Session of Spring School of Experimental and Theoretical Physics, Erevan, May 18–28, 1965). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. 754p.

There were 45 lectures included. Separate abstracts were prepared for each lecture. (J.F.P.)

For abstracts of individual lectures see: 12641–12644, 13636–13638, 13642, 13643, 13647, 13648, 13656–13661, 13690, 13694, 13715–13720, 13734, 13745–13747, 13755, 13756, 13784–13787, 13812–13816, 13823–13826, and 13864.

13690 RELATIVISTICALLY INVARIANT EQUATIONS FOR COMPOUND PARTICLES AND FORM FACTORS. Bogolyubov, N. N.; Matveev, V. A.; Nguyen Van Hieu; Stoyanov, D.; Struminskii, B. V.; Tavkhelidze, A. N.; Shelest, V. P. pp 406-20 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

Among relativistic generalizations of the SU(6) symmetry, the greatest interest was aroused by the theory based on the U(12) group. Within the framework of this scheme, valuable results were obtained pertaining to the form factors of baryons and mesons. The particle form factors were derived from compound models in which mesons and baryons were regarded as bound states of the quark system. It was assumed that the mass of the quark is great; expansion was carried out on the basis of inverse powers of the quark mass. The electromagnetic interaction of compound particles was assumed to be determined by the minimum electromagnetic interaction of quarks. By applying this method, correct absolute values of the magnetic moments of baryons were obtained. The treatment presented was carried out on the basis of results reported by A. Salam et al. (Proc. Roy. Soc., A284: 146(1965)) and Bogolyubov et al. (preprints D-2075 and D-2141, Joint Institute of Nuclear Research, Dubna, 1965). (JPRS)

Electromagnetic

Refer also to abstracts 13767 and 13869.

13691 (DESY-67/32) ZUR SPINABHAENGIGKEIT DER PHOTOPRODUKTION VON NEUTRALEN RHOMESONEN BEI HOHEN ENERGIEN. (Spin Dependence of the Photoproduction of Neutral Rho Mesons at High Energies). Kramer, G. (Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Oct. 1967. 13p. (In German). Dep.

The hypothesis of spin independence for ρ^0 photoproduction is discussed in particular in connection with the strong-absorption model of Eisenberg and co-workers. Under this hypothesis, the ρ^0 mesons are produced with complete spin alignment in the direction of the photon momentum giving a particular simple spin density matrix of the ρ^0 in the Adair system. (auth)

13692 (DESY-67/37) ABSORPTION EFFECTS FOR HIGH ENERGY PHOTONS. Kramer, G.; Schilling, K.; Stodolsky, L. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov. 1967. 13p. Dep.

The contribution of the intermediate vector meson state in photoproduction is equal in strength to the direct Born terms and when combined with the Born term, can give an effect simulating strong absorption for the photon. (auth)

13693 (LPTHE-TH-221) CURRENT ALGEBRA AND K^+-K^0 MASS DIFFERENCE. Capra, F. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Oct. 1967. 12p. Dep.

Using the spectral function sum rules of Weinberg and the soft meson technique, the electromagnetic mass splitting of the kaons is calculated. It is shown that the essential contribution comes from "σ-terms" which can be evaluated with the help of the σ model and of the tadpole theory of Coleman and Glashow. The result depends on the unknown mass of the scalar isoscalar meson σ_8. Identification of the resonance ϵ (700) with this meson gives a mass difference of $\delta m_K = -3.55 \pm 2.71$ MeV in good agreement with experiment. (auth)

13694 INDIRECT METHODS IN KINEMATICS. Kopylov, G. I. pp 325-38 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

To prove the existence of the π^0 meson by a direct kinematic method, one can determine the energy and direction of the two photons into which the meson decays, calculate the mass of the pair of photons, and establish that a resonance exists between the $\gamma\gamma$ mass and the effective mass. However, one can also establish the existence of the meson by indirect methods based on the principle that the angle separating the two photons cannot be less than a certain limit determined by the velocity of the particle from which they are derived or on the fact that the most probable energy of one photon will be $E_\gamma = 1/2\ m_X$, where m_X is the mass of the decaying particle. Indirect methods of this type result in a considerable economy of measurements and constitute what may be referred to as "poor man's kinematics." Some applications of indirect methods are reviewed for identification of particles on the basis of energy spectra, identification of cascade resonances by observing a part of the decay products, and identification of particles by measuring angles. (JPRS)

13695 REGGE-POLE MODEL FOR NUCLEON ELECTROMAGNETIC FORM FACTOR. Narita, Takao (North Japan Coll., Tagajo, Japan). Progr. Theor. Phys. (Kyoto), 38: 1109-15(Nov. 1967).

High-momentum-transfer data on the nucleon electromagnetic form factors are analyzed by using the McMillan-Predazzi's Regge-theoretical formula with several modifications in its treatment. In particular the fact that the effective couplings of this problem have damping effects plays an important role in getting a good fit to the high-momentum-transfer data. For comparison, the same data are analyzed by using the ordinary "resonance-pole" model. These results show that, in order to analyze the high-momentum-transfer data, the Regge-pole model is preferable to the "resonance-pole" model. Regge parameters thus obtained are shown to be slightly different from ones obtained from the high-energy scattering analysis, although the restrictions imposed upon Regge trajectories are different. (auth)

13696 ELECTROMAGNETIC MASS SHIFTS BY DISPERSION THEORY. Taguchi, Yukio; Yamamoto, Kunio (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 38: 1152-67(Nov. 1967).

In the second order approximation of the electromagnetic interaction the mass shifts are expressed in terms of the forward Compton scattering amplitudes of the spacelike photon by the dispersion theoretical treatment. Cottingham's work is generalized. It is emphasized that (1) the results hold for any particle, including the composite particle, with any spin, (2) there are many expressions with different forms depending on the choices of the amplitudes for which we assume the unsubtracted dispersion relation. In spin 0 case, one of them has the contribution from the contact interaction in the elastic part; another expression has the contribution from the contact interaction in the inelastic part. In spin $\frac{1}{2}$ case, Cottingham's result is merely one of these expressions. The result given by the Feynman-Speisman method is another special expression. (auth)

13697 ABSORPTION CORRECTION IN HIGH ENERGY PHOTOPRODUCTION OF π^+. Kikugawa, Masayoshi; Yano, Tadashi; Yonezawa, Minoru (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 38: 1191-3(Nov. 1967).

It is pointed out that the considerable suppression of the cross section at large momentum transfer obtained in previous calculations for $\gamma + p \rightarrow \pi^+ + n$ using the OPE exchange diagram with DWBA-type absorption corrections comes from the particular choice for the πN parameters. It is shown that if the parameters are used which reproduce the elastic πN cross section for all angles the suppression would be smaller than that given by Hori, Kawaguchi, and Shimoida (Nuovo Cim., 44: 1252(1966)). (L.B.S.)

13698 EQUATIONS FOR THE PARTICLE INTERACTION CONSTANTS. Fil'kov, L. V. (Inst. of Physics, Moscow). Yadern. Fiz., 6: 1037-45(Nov. 1967). (In Russian).

The expressions connecting the integrals from imaginary parts of the amplitude in the annihilation channel and in the scattering channel are obtained. These expressions are applied to $\gamma\pi$- and γN-scattering amplitudes to determine the interaction constants of σ-, f-, η-, and X^0 mesons. (auth)

13699 PHENOMENOLOGICAL ANALYSIS OF NEUTRAL PION-PROTON PHOTOPRODUCTION NEAR THE THRESHOLD. Govorkov, B. B.; Minarik, E. V. (Inst. of Physics, Moscow). Yadern. Fiz., 6: 1046-57(Nov. 1967). (In Russian).

On the basis of previous experimental results the phenomenological amplitude analysis of angular distributions of the process $\gamma + p \rightarrow p + \pi^0$ was performed and assuming the electric quadrupole amplitude is zero, the real parts of s- and p-wave amplitudes of the photoproduction E_{0+}, M_{1+}, M_{1-} were found. At the energies 163, 181 and 212 MeV the effect on the multipole amplitudes E_{1+} was estimated. At the energy 234 MeV, using the results of polarization experiments in s-, p-wave approximation, all the four amplitudes E_{0+}, M_{1+}, M_{1-} and E_{1+} were determined. The results of analysis are compared with the various variants of calculations of corresponding values by means of dispersion relations. (auth)

13700 NOTES ON THE SUM RULES FOR THE COMPTON EFFECT AMPLITUDES. Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1058-61(Nov. 1967). (In Russian).

Sum rules following from dispersion relations without subtraction for spin-dependent amplitudes of the nucleon Compton effect at $Q^2 = 0$ are considered. (auth)

13701 ISOBAR N_{33}^* (1236) PHOTOPRODUCTION AND THE CURRENT ALGEBRA. Laperashvili, L. V.; Sholkhet, V. Kh. (Inst. of Physics, Tallin, USSR). Yadern. Fiz., 6: 1062-9(Nov. 1967). (In Russian).

Equal-time commutation relation between the electromagnetic current and the axial-vector charge was used to obtain the amplitude of the process $\gamma + p \rightarrow \pi + N_{33}^*$ (1236) near the threshold of the reaction. Using the experimental data for differential cross section of the process $\gamma + p \rightarrow \pi^- + N_{33}^{++}$ near the threshold energy values allowed one to estimate the value of the coupling constant $\pi^+ N_{33}^{++} N_{33}^{++}$ ($G^2/4\pi = 70 \pm 17$). (auth)

13702 SCHEME OF RECONSTRUCTION OF THE AMPLITUDE OF THE PROCESSES $eN \rightarrow e\pi N$ AND $\pi N \rightarrow Ne^-e^+$ FROM THE EXPERIMENTAL DATA. Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1076-9(Nov. 1967). (In Russian).

Scheme of the reconstruction of the amplitude of the processes $eN \rightarrow e\pi N$ and $\pi N \rightarrow Ne^-e^+$ from the experimental data is given. (auth)

13703 RESONANCE EFFECTS IN THE FIELD OF AN INTENSE LASER RAY. II. Oleinik, V. P. (Inst. of Semiconductors, Kiev). Zh. Eksp. Teor. Fiz., 53: 1997-2011(Dec. 1967). (In Russian).

Resonance Compton scattering of photons on electrons in the field of coherent light is considered. The dependence of the scattered photon frequency on the electron and incident photon 4-momenta and also on the intensity of the light beam is derived. The resonance nature of the differential cross section for Compton scattering is discussed. In order to evaluate the magnitude of the cross section at resonance points the lifetime of electron states with a definite quasi-energy is computed. A numerical estimate shows that the resonance Compton scattering total cross section for laser radiation intensities attainable at present may exceed the ordinary Compton effect cross section by several orders of magnitude. The magnitude of the integral cross section for resonance Moller scattering is estimated. (auth)

13704 TOTAL BREMSSTRAHLUNG SPECTRUM OF ULTRA-RELATIVISTIC ELECTRONS. Baier, V. N.; Fadin, V. S.; Khoze,

V. A. Zh. Eksp. Teor. Fiz., 53: 2194-2202(Dec. 1967). (In Russian).

Bremsstrahlung due to collisions between ultrarelativistic electrons and positrons is considered, the hard end of the spectrum being included. Bremsstrahlung cross sections are obtained which are valid for arbitrary photon energies. It is found that at the end of the spectrum the bremsstrahlung cross section for electron-positron collisions is appreciably greater than that for electron-electron collisions. (auth)

13705 COMPTON SCATTERING ON NUCLEONS. Moroz, L. G.; Tret'yakov, V. N. (Inst. of Physics, Minsk). pp 59-66 of Letnyaya Shkola po Problemam Teorii Elementarnykh Chastits, Kaariku, USSR, Avgust 1965. Tom IV. Palgi, L.; Yiglane, Kh. (eds.). Tartu, Instituut Fiziki Astronomii Estonskoi SSR, 1966. (In Russian).

Experiments on nucleon Compton scattering serve as an independent proof of nucleon structure. Under the action of radiation the distribution of electric charge and magnetic moment of a nucleon varies. The nucleon acquires electrical and magnetic dipole moments on which additional "polarization" scattering takes place. These terms are called the electric and magnetic polarizabilities of the nucleon. Calculations of the dynamic polarizabilities of nucleons are carried out at gamma energies of 60 to 750 MeV. The results show the electric polarizability of a neutron is 20% greater than that of a proton. The magnetic polarizabilities of a neutron is the same as that of a proton. The nucleon has a region of "diamagnetism" and of "paramagnetism." The differential cross section of $(\gamma + \underline{n})$ and $(\gamma + p)$ scattering at any angle shows two maxima at gamma energies of 320 and 660 MeV. Backward scattering is greater than forward scattering with increasing gamma energies. The relative difference between a proton and a neutron decreases with increasing gamma energy. (TTT)

13706 MAGNETIC MOMENT OF THE ELECTRON, MUON, AND BARYONS. Pagels, Heinz (Univ. of North Carolina, Chapel Hill). pp 217-41 of Lectures in Theoretical Physics, Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

The analytic properties of Feynman graphs from the relativistic theory and the sidewise dispersion theory are used to show in a purely nonrelativistic approach how to a first rough approximation the majority of the $a/2\pi$ correction emerges as a direct consequence of the low-energy Thomson rescattering of photons from electrons. The correct relativistic kinematics and the information on the full low-energy theorem on Compton scattering are included The prediction $\frac{1}{2}(g-2)_e = \alpha/2\pi - 0.32848\ \alpha^2/\pi^2 + 0.15\ \alpha^3/\pi^3$ is made. The meson (μ) $g-2$ value is examined in terms of the difference $\frac{1}{2}(g-2)_\mu - \frac{1}{2}(g-2)_e$. Finally the sidewise dispersion relation is applied to the nucleon $g-2$ value. (J.F.P.)

13707 PROTON-NEUTRON MASS DIFFERENCE. Pagels, Heinz (Univ. of North Carolina, Chapel Hill). pp 243-53 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

In the examination of the first-order contributions to the mass difference, the contributions to $\delta M = \delta M^{\gamma} + \delta M^{S}$ arising from the presence of photons δM^{γ} which are directly proportional to $\alpha = 1/137$ and the contribution arising from differences in proton-neutron kinematics, electromagnetic shifts in the strong interaction couplings, etc., are considered separately. In order to estimate the mass difference δM, the formal technique of sidewise dispersion relations are applied to the nucleon graviton vertex considered as an analytic function of the mass of the virtual incoming nucleon with the final nucleon and graviton set on their respective mass shells. (J.F.P.)

13708 LIMIT ON VARIATION OF e^2 WITH TIME. Chitre, S. M.; Pal, Yash (Tata Inst. of Fundamental Research, Bombay). Phys. Rev. Lett., 20: 278-9(Feb. 5, 1968).

Arguments are presented based on geochronological data which show that a billion years ago the value of e^2 was the same as today, to within five parts in ten thousand, if other constants are held invariant. A limit on the variation of e^2 is obtained from the measured spread in ages of meteoritic samples obtained by the uranium-lead method and the potassium-argon method. (L.B.S.)

13709 CIRCULAR POLARIZATION OF PHOTONS IN THE PROCESS $e^+e^- \rightarrow 2\gamma$ AT HIGH ENERGIES. Zel'dovich, B. Ya.; Terent'ev, M. V. JETP Lett. (USSR) (Engl. Transl.), 6: 268-70(Oct. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 818-21(Oct. 15, 1967).

The results of a calculation of the spin correlation in the process $e^+ + e^- \rightarrow 2\gamma$ are presented. This correlation arises in transverse polarization of the electron and positron as a result of the imaginary part of the corresponding amplitude. The imaginary part of the amplitude of this process is connected with radiative corrections. (J.F.P.)

13710 ELECTRODISINTEGRATION OF DEUTERON WITH PRODUCTION OF RESONANCES. Ivanter, I. G.; Yakovleva, I. V. Yadern. Fiz., 6: 1251-7(Dec. 1967). (In Russian).

The differential cross sections of the electrodisintegration of the deuteron with production of the isobars 1236 and 1480 MeV are calculated in the impulse approximation and within the isobar model. The results of calculations are compared with the experiments of Hofstadter and Yearian and are discussed in view of the possible existence of the isotensor component in the electromagnetic current. (auth)

13711 DETERMINATION OF THE ELECTROMAGNETIC FORM FACTORS OF A PARTICLE WITH SPIN 1. Doan-Nhuong (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1258-64(Dec. 1967). (In Russian).

The full experiment to determine the electromagnetic formfactors of a particle with spin 1 at various momentum transfers is proposed. (auth)

13712 TEST OF THE QUANTUM ELECTRODYNAMICS BY ELECTRON-ELECTRON SCATTERING. Budker, G. I.; Kushnirenko, E. A.; Lebedev, R. L.; Naumov, A. A.; Onuchin, A. P.; Popov, S. G.; Sidorov, V. A.; Skrinskii, A. N.; Tumaikin, G. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz., 6: 1221-5(Dec. 1967). (In Russian).

Angular distribution for the electron-electron scattering is measured in the angle range 40-90° at energies 2×43, 2×135, and 2×160 MeV of the colliding electron beams in the storage rings of VEP-1. The measurements are fulfilled using a set of spark chambers with the photographic monitor. The experimental results confirm the validity of the quantum electrodynamics for the distances up to 0.5 f (with 95% confidence). (auth)

Weak

Refer also to abstracts 13839 and 13863.

13713 (JINR-P1-3594) ISSLEDOVANIE VOZMOZHNOSTI EKSPERIMENTAL'NOGO RAZDELENIYA PROTSESSOV PRYAMOI EMISSII I TORMOZNOGO IZLUCHENIYA γ-KVANTOV V RADIATSIONNYKH RASPADAKH K^+-MEZONOV. (On a Possibility of Experimental Separation of Direct Emission Processes and Bremsstrahlung of γ-Quantum K^+-Meson Radiative Decays). Vanyashin, V. S.; Mal'tsev, E. I.; Pestova, G. D.; Solodovnikova, Z. V.; Fadeev, N. G.; Khubua, D. I.; Chuvilo, I. V.; Shoshiashvili, Sh. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 16p. (In Russian). Dep.

A possibility of experimental separation of the direct emission processes and the bremsstrahlung of γ-quanta in the K^+-meson radiative decays is investigated. It is shown that at certain characteristics of the direct emission processes it can be separated experimentally from the bremsstrahlung in an arbitrary infinite detector. (auth)

13714 (JINR-P2-3621) SPINOVYE EFFEKTY V REGENERATSII K^0-MEZONOV. (Spin Effects in K^0-Regeneration). Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 19p. (In Russian). Dep.

The formulas usually used for K^0 regeneration on nuclei with spin $J \geq 1$ are changed due to spin dependence of the forward scattering amplitude. The definition of necessary quantities is given. Spin dependence exists in the amplitudes R, ρ and also in λ_1 and λ_2. The spin dependence of the forward scattering matrix for nuclei with spins 1 and $\frac{3}{2}$, 2 and $\frac{5}{2}$, 3 and $\frac{7}{2}$ is given. The amplitude f is given. With the account of expansion for the spin density matrix one obtains the above mentioned values of nuclear spins. The expression for the total cross sections of interaction with aligned nuclei having spins 3 and $\frac{7}{2}$ is given. Interference experiments after the regeneration on aligned targets is considered. The amplitudes are given. The expression for the two-pion decay are given. The change of the regeneration amplitude phase ϕ_ρ on aligned targets makes it possible to change the character of interference. The dependence of probabilities on $t_3 = \langle T^{33} \rangle (22)$ can have an extremum in which the amplitudes of strong and weak K^0 interactions become related. Expressions give the generalization of the obtained formulas for the case of nuclear spins equal to 3 and $\frac{7}{2}$. The latter value of spin is especially interesting because it is equal to ^{165}Ho spin with the help of which targets with a noticeable degree of alignment were obtained at various laboratories. Even in the absence of the aligned target the existence of the amplitudes B, C... changes general formulas for

regeneration. For nuclei with spins 1 and $^3/_2$ one obtains expressions which are extended in the case of $t_2 \neq 0$. The generalization for the case of nuclei having higher spins is obvious. The Kobzarev–Okun experiment with two plates of different substances can be performed with plates of the same substance, but it is necessary to have, at least, one aligned plate. The change of the degree of alignment makes possible to change smoothly the regeneration properties of targets. The required formulas are given. Besides the weak interactions the study of spin effects in K^0 regeneration is useful for the investigation of spin dependence of strong interaction of K-mesons with nuclei. (auth)

13715 INTERFERENCE EFFECTS IN THE DECAY OF NEUTRAL K-MESONS INTO 2π MESONS. Okonov, E. O.; Podgoretskii, M. I.; Terent'ev, M. V. pp 113-18 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

Effects involving nonpreservation of CP invariance that are due to interference between nonleptonic decay processes of long-lived K_L and short-lived K_s components of a meson K-beam were observed. The study of interference phenomena of these types is of importance for definite identification of the $K_L \rightarrow 2\pi$ decay, the occurrence of which conflicts with the preservation of CP invariance from the standpoint of accepted ideas. In experiments on interference, significant data can be obtained on the characteristics of CP noninvariant interactions, the difference between the masses of K_S and K_L mesons, and the amplitudes of interaction of K- and $\bar{K}$-mesons with matter. Studies of these types will be conducted in the near future. One may expect that in these studies methods will be developed for the convenient determination of a great number of physical constants. (JPRS)

13716 CAPTURE OF MUONS BY NUCLEI. Shapiro, I. S. pp 119-34 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

Experiments on the capture of μ^- by nuclei as a result of the reaction $\mu^- + p \rightarrow n + \nu$, specifically those conducted with ^{40}Ca nuclei by V. S. Evseev, indicated that α, which depends on the parameters of neutron interaction and energy and enters into the expression $A = \alpha\beta$ defining the asymmetry of neutrons (where β takes account of specific properties of the nucleus), reaches a value of ~1 with increasing muon energy, whereas the theory of universal weak interaction demands a value of 0.41. In the calculation of the asymmetry of neutrons, only the simplest nuclei models were used. For this reason one cannot assert that the unexpectedly high asymmetry which follows from the data on the angular distribution of emitted neutrons obtained by Evseev and others is not due to nuclear effects. However, it is difficult to imagine a nuclear model which would explain the observed value of $\alpha \sim 1$. (JPRS)

13717 INTERACTION CONSTANTS IN μ^- CAPTURE. Evseev, V. S. pp 135-41 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

The reaction $\mu^- + p \rightarrow n + \nu$ for absorption of a negative muon by a proton as well as the β-decay of a neutron and μ decay are weak interaction processes with the constant $G = 10^{-49}$ erg · cm. The theory of universal Fermi interaction was developed, which constitutes a generalized expansion of Fermi's theory of β-decay to other weak interactions and is supposed to describe quantitatively the three processes mentioned. This theory was substantiated by experimental data on β- and μ-decay. Its applicability to μ^- capture forms the subject of research being carried out at present. Results obtained in experiments on the angular distribution of neutrons emitted in μ^- capture by compound nuclei were completely at variance with the theory of universal Fermi interaction. Thus doubts arose as to its validity, which seemed to be well established before these experiments were carried out. (JPRS)

13718 ELECTROMAGNETIC STRUCTURE OF THE NUCLEON. Meyer-Berkhout, U. pp 145-80 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

Experiments on the scattering of electrons on nucleons indicated that nucleons have a structure and cannot be regarded as point particles. This structure results in scattering amplitudes that vary with the momentum of the impinging and scattered electrons and can be expressed in terms of electromagnetic form factors. Four form factors, two for the protons and two for the neutron, adequately describe elastic electron scattering on nucleons. The Rosenbluth equation, which was derived on the assumption that the interaction between an electron (or muon) and a nucleon is purely electromagnetic, that quantum electrodynamics are applicable, and that single-photon exchange takes place describes the differential cross sections for elastic electron-nucleon scattering. Experiments on the scattering of electrons on protons were carried out on linear accelerators. Although form factors at momentum transfers up to 6.81 $(BeV/c)^2$ were obtained in experiments on electron–nucleon scattering, there is no experimental proof that the single-photon approximation applies at four momenta higher than 0.8 $(BeV/c)^2$. Complications arise in connection with experiments aimed at establishing the electromagnetic structure of neutrons, because no concentrated neutron targets are available. Scattering on deuterons must be applied and a relation between the form factors for deuterons and nucleons used. The asymptotic behavior of nucleon form factors gives information on the possible existence of a hard core inside the nucleons. (JPRS)

13719 ELECTROMAGNETIC FORM FACTORS OF LEPTONS. Lederman, L. M. pp 181-6 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

No conclusive proofs exist that muons or electrons have any electromagnetic structure distinct from that predicted by Dirac's equation modified by radiation corrections calculated by the conventional methods of quantum electrodynamics. Nevertheless, this problem is considered, because it represents one approach to the old problem of the difference between the mass of an electron and a muon: that is, how a complex structure may result in a mass difference. Futhermore, this problem has a bearing on the structure of nucleons and also on the applicability of conventional quantum electrodynamics. The experimental data were obtained in connection with the formation of e,μ pairs according to the Feynman diagram and involved calculations of elastic scattering, pair formation, and radiation corrections. The data obtained showed in some instances that the behavior of muons was simple and readily explained, while that of electrons did not agree with the requirements of quantum electrodynamics. (JPRS)

13720 PHOTOGENERATION OF ρ- AND ω-MESONS. Strauch, K. pp 214-28 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

A review of the subject from the standpoint of experimental results obtained indicates that at photon energies $E_\gamma < 1.4$ GeV the reaction $\gamma + p \rightarrow p + \pi^+ + \pi^-$ in a significant number of cases takes the course

$$\gamma + p \rightarrow N^{2+} + \pi^-$$
$$\qquad\quad \hookrightarrow p + \pi^+$$

At higher energies the reaction frequency proceeds along the channel

$$\gamma + p \rightarrow \rho^0 + p$$
$$\qquad\quad \hookrightarrow \pi^+ + \pi^-$$

As far as generation of 3 pions is concerned, a significant contribution to the reaction $\gamma + p \rightarrow p + \pi^+ + \pi^- + \pi^0$ is made by the channel

$$\gamma + p \rightarrow p + \eta^0$$
$$\qquad\quad \hookrightarrow \pi^+ + \pi^- + \pi^0$$

at $E_\gamma < 1.1$ BeV, while at higher energies the reaction course

$$\gamma + p \rightarrow p + \omega^0$$
$$\qquad\quad \hookrightarrow \pi^+ + \pi^- + \pi^0$$

becomes of importance. (JPRS)

13721 WEAK INTERACTIONS. Oakes, R. J. (Stanford Univ., Calif.). pp 51-84 of Symposia on Theoretical Physics, Vol. 5. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

Some selected topics in the theory of weak interactions are discussed. These include universal Fermi interaction, θ-τ puzzle, parity nonconservation, general four-fermion interaction, parity, charge conjugation, time reversal, two-component theory of the neutrino, V–A interaction, e-μ ratio, CVC theory, weak magnetism, induced pseudoscalar interaction and the Goldberger–Treiman relation, class II currents, nonleptonic hyperon decays, leptonic hyperon decays, and CP violation. (L.B.S.)

13722 A NOTE ON THE $K_{\mu 4}$ AND $K_{\mu 4}$ DECAY RATES. Berends, F. A. (Instituut-Lorentz, Leiden); Donnachie, A.; Oades, G. C. Phys. Lett., 26B: 109-11(Dec. 25, 1967).

Numerical values are given for the coefficients of the form factors in the decay rate for K_{l4}. In this evaluation explicit account was taken of the pole term in the f_3 form factor. Predictions for the decay rates $K^+ \to \pi^+\pi^-l^+\nu$, $K^+ \to \pi^0\pi^0l^+\nu$, and $K_2^0 \to \pi^-\pi^0l^+\nu$ are given using the form factors obtained from current algebra and those obtained in a recent analysis of the decay $K^+ \to \pi^+\pi^-e^+\nu$. (auth)

13723 RADIATIVE CAPTURE OF μ-MESON AND THE SECOND KIND CURRENTS. Lobov, G. A.; Goreslavskii, S. P.; Lomonosova, T. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 6: 1023-36(Nov. 1967). (In Russian).

The dependence of various effects in the process of radiative capture of muons by free protons and in hydrogen on the weak interaction renormalization constants, was considered. In the total probabilities of radiative capture of muons, in photons spectra and in their circular polarizations, the terms of the order of magnitude $(m_\mu/m)^2$ (m_μ, m—are the masses of muon and nucleon) were taken into account. The strong dependence of considered radiation capture characteristics on the weak interaction renormalization constants may be used to establish the kind of interaction of muons with nucleons. (auth)

13724 W-MESON PAIR PRODUCTION ON A NUCLEUS. Bolsun, A. I.; Satsunkevich, I. S. (Inst. of Physics, Minsk). pp 49-51 of Letnyaya Shkola po Problemam Teorii Elementarnykh Chastits, Kaariku, USSR, Avgust 1965. Tom IV. Palgi, L.; Yiglane, Kh. (eds.). Tartu, Instituut Fiziki Astronomii Estonskoi SSR, 1966. (In Russian).

The search of μ-pairs at large angles to the direction of the gamma quantum can serve as a measure of W-meson pair production. At high energies of the gamma quanta, the angular distribution of the decay leptons is strongly biased in the forward direction. Expressions are given for the production cross section of linearly polarized mesons on a nucleus at high gamma energies, and for the distribution of decay leptons after the linearly polarized W-mesons have decayed in flight. (TTT)

13725 SOME CONSEQUENCES OF THE THEORY OF INVERSE μ-e DECAY. Shishkin, G. V. (Inst. of Heat and Mass Transfer, Minsk). pp 71-4 of Letnyaya Shkola po Problemam Teorii Elementarnykh Chastits, Kaariku, USSR, August 1965. Tom IV. Palgi, L.; Yiglane, Kh. (eds.). Tartu, Instituut Fiziki Astronomii Estonskoi SSR, 1966. (In Russian).

Processes of inverse μ-e decay are considered. The existence of these processes are predicted by the general scheme of weak interactions: (a) $\bar{\nu}_e + e^- \to \nu_\mu + \mu^-$; (b) $\nu_\mu + e^- \to \nu_e + \mu^-$; (c) $\nu_e + e^+ \to \nu_\mu + \mu^+$; and (d) $\bar{\nu}_\mu + e^+ \to \bar{\nu}_e + \mu^+$. The processes of inverse μ-e decay are considered for two forms of the Hamiltonian involving either neutral particles ($\nu_e\nu_\mu$) and ($e\mu$) or charged particles ($e\nu_e$) and ($\mu\nu_\mu$). The weak interaction constants G_V and G_A are selected arbitrarily. Expressions are obtained for the differential cross sections of the inverse μ-e decay and of the degrees of longitudinal and transverse polarizations of the muons formed under arbitrary initial conditions (arbitrary polarization of the target) for both types of the Hamiltonian. These expressions are not presented, but some of the conclusions are given. The probabilities of μ-e decay and the degrees of polarization depend on the Hamiltonian which is used, especially at low energies. In the general case of an arbitrarily polarized target the probabilities of processes a, b, c and d are different. The polarization properties of muons in inverse μ-e decay do not depend on the weak interaction constant G_V and G_A in the case of a charged particle Hamiltonian. The polarization of the various particles is discussed. (TTT)

13726 MOMENTUM DEPENDENCE OF THE K_{l3} DECAY FORM FACTORS. Fitelson, M.; Kazes, E. (Pennsylvania State Univ., University Park). Phys. Rev. Lett., 20: 304-5(Feb. 5, 1968).

When the formal solution to the algebra of currents is saturated with vector-meson resonances, the first-order momentum dependence of $f_+(q^2)$ is related to $\Gamma(\omega \to \pi^0 + \gamma)$ and is in agreement with experiments on K_{l3}^+ and K_{l3}^+ decays. (auth)

13727 DOMINANCE OF THE ρ AND A_1 MESONS IN THE $\pi \to e\nu\gamma$ DECAY. Vainshtein, A. I. (Novosibirsk State Univ., USSR). JETP Lett. (USSR) (Engl. Transl.), 6: 266-8(Oct. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 815-17(Oct. 15, 1967).

It is shown in previous assumptions, that the main contribution to the spectral function of the vector current is made by the meson (φ), and that of the axial current by the meson (A_1) and the meson (π), that the ratio of the masses of the mesons (A_1) and (ρ) is equal to $\sqrt{2}$, make it possible to find the axial part of the amplitude of the $\pi \to e + \nu + \gamma$ decay. The hypothesis of the partial conservation of the axial current is also used. (J.F.P.)

13728 RELATIVISTIC EFFECTS IN THE THEORY OF MUONIC CAPTURE BY NUCLEI. Novikov, V. M.; Urin, M. G. Yadern. Fiz., 6: 1233-40(Dec. 1967). (In Russian).

The dependence of relativistic (in nucleons) effects on the total probability of μ-capture and on the asymmetry of emission of direct neutrons is investigated. In the frame work of finite Fermi-system theory, a simple relation which allows one to express the relativistic matrix elements through the nonrelativistic ones, is obtained. The calculations of μ-capture velocity are performed in quasiclassical approximation for the nuclei with $A \geq 40$. It is shown that the relativistic effects can result in the change of the sign of asymmetry coefficient. (auth)

13729 LEPTONIC DECAYS OF HYPERNUCLEI. Lyul'ka, V. A. Yadern. Fiz., 6: 1226-32(Dec. 1967). (In Russian).

Leptonic decays ${}_\Lambda H^4 \to {}^4He + e^- + \bar{\nu}_e$ (1) and ${}_\Lambda H^4 \to {}^4He + \mu^- + \bar{\nu}_\mu$ (2) are considered. For them the spectrum of the recoil nuclei ^{4}He, the angular lepton-neutrino correlation as well as the μ-meson polarization in the decay (2) are calculated. Some possibilities of checking the V – A-theory for hyperon decays as well as the effects due to the possible admixture of induced scalar in the decay (2) are discussed. Estimates for the life time and relative probabilities of these decays are given. The decays ${}_\Lambda H^4 \to {}^3H + p + e^- + \bar{\nu}_e$, ${}_\Lambda He^4 \to {}^3He + p + e^- + \bar{\nu}_e$ are briefly discussed. (auth)

13730 ELECTROMAGNETIC FINAL-STATE INTERACTION AND T-ODD CORRELATIONS IN LEPTONIC BARYON DECAYS. Okun, L. B.; Khriplovich, I. B. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 6: 1265-76(Dec. 1967). (In Russian).

T-odd correlations in leptonic baryon decays due to the electromagnetic finite-state interaction are calculated. It is shown that in some cases the expected T-odd correlations are very small, the fact that provides possibility for a high accuracy experimental investigation of the possible effects of the CP violation. Precise measurements of the electromagnetic correlations in the hyperon decays may, in principle, give some information on the hyperon electromagnetic properties as, for example, the static magnetic moments of hyperons, the $(\Sigma^0 \to \Lambda\gamma)$-transition magnetic moment, and the electromagnetic hyperon form factors. However for this purpose the available statistics of the decays is to be increased by many orders of magnitude. (auth)

13731 INTEGRAL FORM OF PCAC AND WEINBERG SUM RULES. Krolikowski, W. (Inst. for Nuclear Research, Warsaw. Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 735-8(1967).

An integral form of the PCAC is considered. Starting from the usual differential form of PCAC an additional divergenceless term is introduced in order to write the integral equivalent of the PCAC. Since this divergenceless term must have a physical interpretation, it is conjectured that this term is proportional to the field of the meson (A_1^-). Such an identification is suggested by the spin–parity and isospin assignments for the A_1 (1080). Using the Weinberg relation the coupling constant $g_{A_1NN}: \tilde{g}_{A_1NN}^2/4\pi$ is estimated to be 1.9. By means of the integral form of PCAC one can also relate the process $A_1^- \to l^- + \nu$ with the processes $A_1^+ \to \rho^+ (\rho^0) + \pi^0 (\pi^+)$, $\rho^- \to \pi^0 + l^- + \nu$ and $\rho^0 \to \pi^+ + l^- + \nu$. (J.F.P.)

Strong (General)

Refer also to abstracts 13863 and 13869.

13732 (ITF-67-33) OBOBSHCHENNAYA ALGEBRA TOKOV I GIPOTEZA ADDITIVNOSTI. (A Generalized Current Algebra and the Additivity Hypothesis). Zav'yalov, O. I.; Slavnov, A. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 9p. (In Russian). (CONF-670544-4).

From Conference on Axiomatic Quantum Field Theory and Elementary Particles, Kiev, USSR.

The interrelation between the Regge pole hypothesis and that of additivity of quark amplitudes is found. The signatures of vacuum and octet contributions into the scattering amplitude are calculated. (auth)

13733 (PUC–937-284) WHY WE NEED BETTER HIGH ENERGY TOTAL CROSS SECTION MEASUREMENTS. Lipkin, Harry J. (Princeton Univ., N. J. Palmer Physical Lab.). Nov. 1967. Contract AT(30-1)-937. 9p. (CONF-680103-3). Dep. CFSTI.

From Conference on High-Energy Collisions of Hadrons, Geneva, Switzerland.

The particular importance for a better understanding of hadron dynamics of total cross section measurements at higher energies and of more precise measurements in the energy of 6 to 20 GeV is pointed out. Total cross sections, regularities in experimental

data, symmetry and universality, and possible experimental approaches are considered. (J.F.P.)

13734 QUARKS: THEIR ASTROPHYSICAL AND PHYSICO-CHEMICAL ASPECTS. Zel'dovich, Ya. B.; Okun', L. B.; Pikel'ner, S. B. pp 421-35 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

Classification of known strongly interacting particles within the framework of the SU(3) and SU(6) symmetries led to the conclusion that particles named quarks must exist, which have a charge of +2/3 e or −1/3 e. Consideration of the problem of detection and isolation of quarks (cf Zel'dovich et al., Uspekhi Fizicheskikh Nauk, 86(4): (1965)) indicated that the fact that they have not been detected as yet is not surprising. In the primary expansion of the metagalaxy, quarks burn out intensively, so that their concentration becomes of the order of 10^{-9} to 10^{-18} per nucleon, even if the initial concentrations of quarks and nucleons had been similar. If the positively charged quarks are lighter and therefore more stable, their burning out continues in the inside regions of stars. Negatively charged quarks are preserved as a result of their adhesion to atomic nuclei. The fact that quarks have not been detected hitherto supports the assumption that positive quarks are more stable than the negative. One must keep in mind, however, that in galactic evolution, part of the gas does not pass through stars and therefore must preserve the initial concentration of quarks. Attempts to detect quarks under terrestrial conditions must consider their physico-chemical properties such as solvation in aqueous solutions and deposition on the walls in the presence of nonpolar solvents. Under laboratory conditions, the best ways of detecting quarks would be by determining the elementary charges in macrobodies and by applying mass spectrometry. (JPRS)

13735 QUARK MODEL FOR HIGH-ENERGY SCATTERING: A TEST OF ADDITIVITY FROM JOINT DECAY DISTRIBUTIONS. Bialas, A. (Jagellonian Univ., Krakow. Inst. of Nuclear Physics, Krakow); Zalewski, K. Phys. Lett., 26B: 170-3(Jan. 8, 1968).

Experimental data about the decay distributions in double resonance production are used to test the predictions of the quark model depending only on the additivity assumption. Within the rather large experimental inaccuracies good agreement is found. (auth)

13736 THE STATISTICAL CHARACTER OF HADRON PRODUCTION AT HIGH ENERGIES IN THE THEORY OF COMPLEX ANGULAR MOMENTUM. Anselm, A. A.; Dyatlov, I. T. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett., 26B: 100-3 (Dec. 25, 1967).

The multiple production of hadrons at high energies is considered by means of the "reggeon diagram technics." It is shown that under some kinematical restrictions (in particular the small values of the perpendicular components of the impulses of the particles produced) the many-particle amplitude is reduced to the two-particle amplitude due to the fact that the emission of hadrons occurs to be independent one of another like the radiation of soft photons in electrodynamics. This rule is applicable only for production of such hadrons which can not be emitted by the Pomeranchuk pole (because of their quantum numbers) but only by some reggeon carrying the proper quantum numbers and determining the asymptotics of the two-particle process. (auth)

13737 QUARK MODEL WITH FACTORIZABILITY ASSUMPTION. Kawaguchi, Masaaki; Sumi, Yoshio; Yokomi, Hiroyuki (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 38: 1183-4(Nov. 1967).

The quark model with the factorizability assumption previously discussed for high-energy elastic scattering at 90° in the cms is extended to the case of arbitrary cm angle θ. (L.B.S.)

13738 QUARK MODEL AND ELASTIC SCATTERING AT 90^0. Kawaguchi, Massaki; Sumi, Yoshio; Yokomi, Hiroyuki (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 38: 1178-80 (Nov. 1967).

High-energy elastic scattering at 90° in the cms is discussed on the basis of a simple quark model with a new assumption — the factorizability assumption. In this assumption the scattering amplitude is proportional to the number of independent diagrams in which the constituent quarks are only scattered at finite angle without exchange interaction, pair creation and pair annihilation. (L.B.S.)

13739 QUARKS AS QUASI-PARTICLE AND THE CLUSTER MODEL OF HADRONS. Imachi, Masahiro (Nagoya Univ., Japan); Otsuki, Shoichiro; Sawada, Shoji; Toyoda, Fumihiko. Progr. Theor. Phys. (Kyoto), 38: 1177-8(Nov. 1967).

It is shown that a quasi-particle can be defined by many-sakaton systems with the cluster structure and that it gives a substantial explanation of the fractional quantum numbers of the quark. (L.B.S.)

13740 PROPAGATION FUNCTIONS, RENORMALIZATION CONSTANTS, AND THE ELEMENTARY OR COMPOUND CHARACTER OF PARTICLES. Stihi, M.; Visinescu, M. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 19: 1019-45 (1967). (In Rumanian).

It was attempted to establish a relation between the field theory and the values involved in strong interactions, following up current studies in the theory of strong interactions concerning the elementary or complex nature of particles. In principle, this means that it must determined which values must be introduced into the theory and which ones may be derived from it. Assuming that the renormalization constants of the field theory represent a satisfactory criterion for this purpose, an attempt was made to find a suitable expression for these constants within the framework of strong interactions, without recourse to perturbation theory. The theory of scattering was reviewed, introducing the concept of the S-matrix. After discussing the propagation functions and the conditions of renormalization, their Lehmann representation was derived. From the study of the properties of the propagation function, the definite, positive characteristics of the spectral function $\sigma(m^2)$ could be established. (TTT)

13741 DIFFRACTION MODEL FOR STRONG INTERACTIONS AND THE SHRINKAGE OF THE DIFFRACTION PEAK. Krisch, A. D. (Univ. of Michigan, Ann Arbor). pp 1-17 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

The diffraction model for strong interactions at high energies is considered. A model is assumed having a spherically symmetric interaction probability density which is squashed down in the direction of the motion by the Lorentz contraction. This model leads to the prediction that the differential elastic scattering cross section should depend only on $B^2p_\perp^2$. When the p + p and π + p elastic data are plotted against this variable, the energy dependence is removed. Thus this model seems to offer a kinematic explanation for the well-known shrinkage of the diffraction peak. (J.F.P.)

13742 BOOTSTRAPPING, STATIC MODELS, AND STRONG COUPLING. Goebel, C. (Univ. of Wisconsin, Madison). pp 281-311 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

Some solutions of the Cutkosky bootstrap equations are briefly sketched, and their relation to the strong coupling bootstrap equations is discussed. These bootstrap equations result from consideration of the Bethe–Salpeter wave equations in the ladder approximation, taking the particles as having equal masses. (J.F.P.)

13743 LARGE-ANGLE ELASTIC SCATTERING. Andreev, I. V.; Dremin, I. M. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 262-6(Oct. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 810-15(Oct. 15, 1967).

An expression for the imaginary part of the elastic amplitude is obtained from the unitarity condition in the form Im A ~ exp (−bpθ/2), where p and θ are the momentum and scattering angle in the cms. The unitarity condition is considered directly for angles θ outside the diffraction cone. Using a reasonable approximation for the amplitudes based on experimental data on the differential cross sections, it is verified that the main contribution to the integral for the unitarity condition is made by two small symmetrical regions of angles from the conditions for the integration region. (J.F.P.)

Strong (Baryon No. = 0)

13744 (IPNO/TH-108) FORWARD NN AND N$\bar{\text{N}}$ CHARGE EXCHANGE SCATTERING AT HIGH ENERGY. Gauron, P.; Lacombe, M. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). Nov. 1967. 10p. Dep.

The existence of the speculative ρ', having the same quantum numbers as the ρ, is assumed, and N + N and N + $\bar{\text{N}}$ scattering only are considered. The possibility of additional terms in the forward differential cross sections permits the ρ' parameters to be varied. Then solutions consistent either with evasion or conspiracy can be found, the latter fitting the data slightly better. But these two eventualities cannot be distinguished due to experimental uncertainties. The possibility of a ρ P cut is considered. Although crude approximations were used, it seems impossible to fit the forward differential cross sections without the help of a conspir-

acy, either of the cut with itself or between poles. Good results were obtained with a pole A_1 such that $\alpha_1(0) = -0.2$. But a self-conspirating cut cannot be excluded. (J.F.P.)

13745 REVIEW OF BOSON RESONANCES. Goldhaber, S. pp 243-72 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

Results of work on multipion resonances are reviewed. Determination of the spin of boson resonances, A_1 and A_2 mesons, the B boson, resonances in the system $K\pi\pi$, general remarks on the system $K\bar{K}\pi$, the D-meson peak in the system $KK\pi$ at 1285 MeV, the E meson, data on the $K\bar{K}\pi$ (1510) resonance, data on a new resonance in the system 2π at 700 MeV, the M_1-meson peak in the system KK at 1280 MeV with S = +2, the modes of decay of an ω meson, the reactions $K^+d \rightarrow K^+d$ and $K^+d \rightarrow K^+d\pi$ are considered. Particular attention is paid to data which were not covered completely in a review by G. Goldhaber (2nd Coral Gables Conference on Symmetry Principles at High Energy, p. 34, W. H. Freeman and Co., San Francisco, 1965). (JPRS)

13746 ABSOLUTE UPPER LIMIT OF PION–PION SCATTERING AMPLITUDE. Martin, A. pp 524-34 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

A consideration of the amplitude of $\pi\pi$ scattering in all possible interactions of neutral or charged pions in the presence or absence of other particles indicated that a definite upper limit must be imposed on this amplitude by the requirements of analyticity and unitarity. This result may be regarded as precise, although the upper limit cannot at the present stage be checked on the basis of experimental data. Application of unitarity and analyticity should therefore not be regarded as based on empty theoretical constructions. It was also established that the sum rule obtained for full cross sections imposes an additional limitation on any inelastic processes initiated by two pions. In the treatment in question, the region below the elastic scattering threshold was considered. (JPRS)

13747 SOME CONSEQUENCES OF ANALYTICITY AND UNITARITY. Martin, A. pp 541-55 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

The problem of asymptotic upper and lower limits of scattering amplitudes is considered. It is shown that unitarity, analyticity, and crossing symmetry impose definite limitations on the magnitude of pion-pion interactions. (JPRS)

13748 PROJECTION OPERATORS IN BOSON THEORY. Borgardt, A. A.; Yaroshenko, A. P. pp 5-41 of Letnyaya Shkola po Problemam Teorii Elementarnykh Chastits, Kaariku, USSR, Avgust 1965. Tom IV. Palgi, L.; Yiglane, Kh. (eds.). Tartu, Instituut Fiziki Astronomii Estonskoi SSR, 1966. (In Russian).

The presentation is divided into three parts. The first lecture covers the use of projection operators in problems of the relativistic quantum mechanics of bosons. An algebra of reducible representation (Kemmer algebra) is of practical use in the theory. A transition is made to the use of projection operators which result in the isolation of a sub-space with definite geometrical properties. Three-dimensional and four-dimensional representations are presented as examples of systems of projection operators. The second lecture covers projection operators in wave fields. The field in four-dimensional space, three-dimensional projection operators in four-dimensional representations, projection operators in Hilbert space, and the exclusion of non-canonical variables in the wave equation are presented. The third lecture covers the vector meson in a central field. A solution of the Kepler problem for a vector particle is sought by Kemmer algebra with the use of projection operator theory, which explains the structure of the wave function and allows a separation of variables. The wave equation and motion integrals, the spin-angular functions, and the separation of variables in the wave equation are presented in this mathematical form. (TTT)

13749 ON SOME CORRELATION PROPERTIES OF THE $K^0\bar{K}^0$-PAIRS. Lyuboshits, V. L.; Okonov, E. O.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1248-50(Dec. 1967). (In Russian).

Some correlations in strong decays of the pair $K^{0*}\bar{K}^{0*}$ into neutral particles are considered. It is shown that if CPT is violated, the $K^0\bar{K}^0$ pair at even orbital momenta may decay according to the scheme $K_L K_S$. (auth)

Strong (Baryon No. = 1)

13750 (CALT-68-145) REGGE POLES AND HIGH ENERGY πN SCATTERING. Frautschi, Steven (California Inst. of Tech., Pasadena). Dec. 1967. Contract AT(11-1)-68. 25p. (CONF-671203-2). Dep. CFSTI.

From Conference on πN Scattering, Irvine, Calif.

A review is given of the outstanding structural features from attempts to understand higher energy scattering by means of Regge poles, much as first, second, third resonance were outstanding in the low-energy scattering. The case of $\pi^- + p \rightarrow \pi^0 + n$ interactions at small t is analyzed. Elastic $\pi^+ + p$ and $\pi^- + p$ scattering are also considered. (J.F.P.)

13751 (COO-264-412) REMARKS ON LOW-ENERGY PION-NUCLEON SCATTERING. Sakurai, J. J. (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies. Contract AT(11-1)-264. 10p. (EFINS-67-98; CONF-671203-3). Dep. CFSTI.

From Conference on πN Scattering, Irvine, Calif.

From the review given of meson (π)–nucleon interaction theory it is concluded that the advances in PCAC and current algebra essentially justify the conjecture that the low-energy scattering amplitude is due to the nucleon Born term computed according to the gradient coupling prescription plus the ρ exchange term computed in accordance with the universality principle. It is postulated that the basic problems of the discussed meson (π)–nucleon scattering lengths are solved. (J.F.P.)

13752 (ITF-67-19) RENORMALIZATION OF THE AXIAL-VECTOR CURRENT. Baluni, Varukhan Zavonovich; Enkovski, Laslo Laslovich; Kukhtin, Valerii Vasil'evich (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 8p. Dep.

It is shown that the Adler–Weisberger relation can be obtained in any theory exhibiting a symmetry between the axial and axial-vector currents in the sense that corresponding bare constants are equal. (J.F.P.)

13753 (LPTHE-TH-226) A POSSIBLE EXPLANATION OF THE LAMBDA TO SIGMA RATIO IN THE ISOSPIN-1 S-WAVE $\bar{K}$ N REACTION IN A QUARK MODEL DESCRIPTION. Renard, F. M. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Nov. 1967. 10p. Dep.

A proposal is given for explaining the discrepancy between the calculation of the parameter ϵ in the quark model and its experimental value. In addition to the single quark amplitude a diquark amplitude of the backwards-scattering-type is considered; its value is determined independently from $K^- + p \rightarrow \Sigma + \pi$ cross sections; the prediction for ϵ agrees then with experiment, but is very sensitive to the low energy $\bar{K}$ + p parameters. (auth)

13754 (ORNL–4197) PION–NUCLEON DIFFERENTIAL CROSS SECTIONS IN THE 0 TO 700-MeV ENERGY REGION IN TERMS OF THE COULOMB SCATTERING AMPLITUDE, COULOMB PHASE SHIFTS, AND NUCLEAR PHASE SHIFTS UP TO l = 4. Bertini, Hugo W. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 25p. Dep. CFSTI.

A derivation of the expression for the pion-nucleon differential scattering cross section in terms of the nuclear phase shifts is presented. It follows that of Ashkin. The method for altering this expression in order to obtain the cross section for all charge states of the pion and nucleon is described where simple isotopic spin analysis is employed. Coulomb and absorption effects are incorporated in the manner described by Roper, Wright, and Feld. A detailed and lengthy equation for the cross section in terms of the electromagnetic amplitudes, Coulomb phase shifts, and nuclear partial-wave amplitudes is presented where the multiplication of the usual series expansion for the cross section was carried out for terms up to l = 4. Instructions are given for the substitution of appropriate expressions into the equation for the cross section so that it will apply to each charge state of the pion and nucleon. These expressions are functions of the nuclear phase shifts, the Coulomb phase shifts, and the absorption parameters. A table of the phase shifts and absorption parameters published by Roper et al. is included. The work described is utilized in an intranuclear cascade calculation for interactions up to about 3 GeV. (auth)

13755 EXPERIMENTAL STUDY OF NUCLEAR AMPLITUDES IN FORWARD ELASTIC PROCESSES AT HIGH ENERGIES. Nikitin, V. A.; Sviridov, V. A.; Strunov, L. N. pp 609-26 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

On the basis of the optical model, the imaginary part Im A of forward scattering increases infinitely with increasing energies, while there is no reason for a corresponding increase in the real amplitude Re A of scattering. With energies tending to approach infinity, the ratio α = Re A/Im A approaches zero. At present α can be determined and the basic principles of the theory checked by relating Re A (0) through the principles of causality, unitarity, and Lorentz invariance to the observed cross sections of scattering. Experimental data obtained by Nikitin and others on

elastic pp-, π^+p-, and π^-p-scattering accompanied by the charge exchange $\pi^-p \rightarrow \pi^0n$ indicated that at energies ≤ 1 BeV the calculated magnitude of meson-proton scattering agreed with experimental results. At energies of 3 to 18 BeV, the agreement both for meson-proton elastic scattering and scattering accompanied by charge exchange was not so good. The necessity of increasing in π^-p experiments the precision of determinations of full cross sections and of elastic scattering determinations in the Coulomb interference region became apparent. It is possible that at high energies disturbances of microcausality at dimensions $<10^{-14}$ cm affect the results. (JPRS)

13756 CHARGE EXCHANGE $\pi^- + p \rightarrow \pi^0 + n$ AT HIGH ENERGIES. Shebanov, V. A. pp 627-37 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

A review of experimental data on the reaction $\pi^- + p \rightarrow \pi^0 + n$ indicates that the full cross section of this reaction from 1.5 to 6 to 8 BeV/c varies approximately as $1/P^n_{\pi^-}$, where $n \sim 2$. At 10 to 18 BeV/c, n is close to 1. Data on the differential distribution $d\sigma/dt(t)$ indicate that the charge exchange does not take place at great distances, as distinguished from π^+-p scattering. The reaction at 6 to 18 BeV/c can be described on the assumption of the exchange of a single ρ trajectory with $\alpha\rho(0) \cong 0.6$. At high energies the charge exchange is sensitive to the difference in the behavior of π^+-p and π^--p cross sections and to the presence of isobars with both I = 1/2 and I = 3/2. Irregularities in the course of the $d\sigma(0^0)\ d\Omega$ cross section indicate the existence of new isobars. The $\pi^- + p \rightarrow \pi^0 + n$ reaction has characteristics that resemble in some respects, as far as full cross sections and differential distributions are concerned, those of $K^- + p \rightarrow \bar{K}^0 + n$. (JPRS)

13757 EVIDENCE FROM πp PHASE SHIFT ANALYSIS FOR NINE MORE POSSIBLE NUCLEON RESONANCES. Donnachie, A.; Kirsopp, R. G.; Lovelace, C. (CERN, Geneva). Phys. Lett., 26B: 161-5(Jan. 8, 1968).

From πp phase shift analyses at 59 energies, linked with partial wave dispersion relation fits, the probable existence of nine new nucleon resonances in the mass range 1680 to 2190 MeV, all with very small branching ratios to the elastic channel, is suggested. (auth)

13758 PROJECTIONS ON EXCHANGED SYSTEMS WITH WELL DEFINED QUANTUM NUMBERS, AND AN APPLICATION TO ω PRODUCTION. Hogaasen, H. (Faculte des Sciences, Paris); Lubatti, H. J. Phys. Lett., 26B: 166-9(Jan. 8, 1968).

Some expressions which are products of density matrix elements of meson resonances and the differential cross section for the production of the resonances are presented. These bilinear expressions isolate the effect of exchanges with unusual quantum numbers. The procedure, which is model independent, can hopefully be used in the Regge pole model to determine the Regge trajectories of exchanges such as the $C = -1$ abnormal parity systems (for example the B and its SU_3 isoscalar Y = 0 partner). It is shown that there are suggestive features in ω production that seem to support a decrease of the ρ exchange contribution at $t = -0.6$ $(GeV/c)^2$ as predicted by the Regge pole model. (auth)

13759 DEGENERATE REGGE TRAJECTORIES AND PARITY DOUBLETS OF BARYON RESONANCES. Barger, V.; Cline, D. (Univ. of Wisconsin, Madison). Contract AT(11-)-881. Phys. Lett., 26B: 85-7(Dec. 25, 1967). (COO-881-116).

The MacDowell reflection symmetry as applied to Regge recurrences of SU(3) multiplets is suggested as a natural explanation of recent experimental observations of parity doublets of baryon resonances (resonance pairs with approximately equal masses, the same Y, I, and J values and opposite parities). (auth)

13760 ANALYSIS OF SINGLE-PION PRODUCTION REACTIONS $\pi^+ + p \rightarrow \pi^+ + \pi^0 + p$, $\pi^+ + \pi^+ + n$ BELOW 1 BeV. Nakamura, Yoshiko Oi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 38: 1116-33(Nov. 1967).

The single-pion production reactions $\pi^+p \rightarrow \pi^+\pi^0p$, $\pi^+\pi^+n$ below 1 BeV are analyzed by using the "generalized isobar model" based on the Lovelace equation. The "generalized isobar model" includes the effect of the pion cloud around the nucleon in addition to the (3-3) isobar production of the usual isobar model. The estimate of the production amplitude includes no adjustable parameter. The charge ratio $\sigma(\pi^+p \rightarrow \pi^+\pi^0p)/\sigma(\pi^+p \rightarrow \pi^+\pi^+n)$, the distribution of Treiman Yang angles ϕ and β, and the angular distributions of final pions in the overall center of mass system are calculated. The agreement with experiment is much improved compared with the usual isobar model. (auth)

13761 VECTOR MESON REGGE POLES AND KN SUPERCONVERGENCE SUM RULES. Yoshimura, Motohiko (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 38: 1146-51(Nov. 1967).

Under the assumption that scattering amplitudes at high energy are dominated by the Regge-pole exchanges based on SU(3), two sum rules of the superconvergent type are derived in the case of KN and $\bar{K}N$ forward scattering. Both the Regge-pole residue and f/d ratio for the vector meson are calculated using low energy data, which agree with the values obtained by Barger and Olsson's high energy analysis. (auth)

13762 PHENOMENOLOGICAL MODEL OF THE ps-MESON PRODUCTION NEAR THE THRESHOLD. Kanazawa, Akira; Terasawa, Osamu (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto), 38: 1180-1(Nov. 1967).

A simple phenomenological model is proposed for the single pseudoscalar meson production near threshold in the following interactions: $\pi^- + p \rightarrow n + \eta$; $\pi^- + p \rightarrow \Lambda + K^0$; $\pi^+ + n \rightarrow \Sigma^+ + K^+$; $\pi^- + p \rightarrow \Sigma^- + K^+$; and $\pi^- + p \rightarrow \Sigma^0 + K^0$. It is shown that these interactions can be well described by a simple effective interaction Hamiltonian which is the SU(3) analog of the well-known ϕ^2 interaction in πN scattering. (L.B.S.)

13763 A POSSIBLE DECUPLET OF THE BARYON RESONANCES WITH $J^P = 1/2^-$. Minami, Shigeo (Osaka City Univ.). Progr. Theor. Phys. (Kyoto), 38: 1197-8(Nov. 1967).

The following model is proposed as a possible decuplet of baryon resonances with $J^P = 1/2^-$: The $\Sigma(1700)$ is a member of the decuplet to which the $\Delta(1670)$ belongs. The model predicts as members of the same decuplet a resonance $\Xi(1730)$ with $J^P = 1/2^-$, and a resonance $\Omega(1760)$ with $J^P = 1/2^-$ and I = 0. The possibility that the new $\Xi(1705)$ resonance indicated in recent experiments corresponds to the $\Xi(1730)$ is suggested. (L.B.S.)

13764 BI-PERIPHERAL MODEL FOR THE PROCESS $\pi^+ + p \rightarrow N^{*++} + \rho^0 + \rho^0$. Ajduk, Z.; Bialkowski, G. (Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 579-82(1967).

A brief and preliminary report on a systematic examination of the peripheral model, based on assumptions similar to those previously used, is applied to processes with three particles in the final state. The process $\pi^+ + p \rightarrow N^{*++}(1236) + \rho^0(760) + \rho^0(760)$ is studied. (J.F.P.)

13765 EVIDENCE FOR N* REGGE TRAJECTORY CLANS WITH APPROXIMATE PARITY DEGENERACY. Barger, V.; Cline, D. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 20: 298-9(Feb. 5, 1968).

Resonances recently discovered in πN phase-shift analyses are assigned to linear Regge trajectories. The proposed classification is interpreted as evidence for (i) secondary trajectories displaced down from the leading trajectories by $\alpha_S \simeq \alpha_L - n$(n an integer) and (ii) approximate degeneracy of trajectories with opposite parity, the same signature, and equal isospin (i.e., MacDowell symmetric). (auth)

13766 CONSTRAINTS ON πN PHASE SHIFT ANALYSES FROM ANGULAR DISTRIBUTIONS OF PRODUCTION REACTIONS. Uretsky, J. L. (Argonne National Lab., Ill.). pp 123-31 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

The correct phase shifts and inelasticities for the reaction $\pi + N$ are determined with no built-in prejudices concerning angular momentum states or energy dependences. The analysis is based on an exact formalism for production reactions which does not involve a decomposition in terms of relative angular momenta of two-body subsystems in the final state. (J.F.P.)

13767 CURRENT ALGEBRAS, THEORY, AND APPLICATIONS. Balachandran, A. P.; Gundzik, M. G.; Nicodemi, F. (Syracuse Univ., N. Y.). pp 361-75 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

An attempt is made to develop the Sugawave-Suzuki method in such a way that it becomes a more precise and useful tool for computing low-energy parameters of physical systems. Local statements about off-mass-shell extrapolations of scattering amplitudes are obtained, and a definite set of rules for computing scattering amplitudes of a physical mass boson is developed from the knowledge of the behavior of the extrapolated amplitude in the neighborhood of the point where the four-momentum of the boson vanishes. The computation technique used is described for $\pi^+ + p$ scattering. The general question of the extrapolation of the scattering amplitudes off its mass shell is discussed. A calculation discrepancy is resolved, and the modifications to the current conservation condition for off-mass-shell amplitudes involving photons are illustrated. Finally, an attempt is made to describe precisely the significance of the Haag-Nishijima theorem for current algebra calculations. (J.F.P.)

13768 INFLUENCE OF ISOBAR PRODUCTION ON CHARGE RATIO AND TRANSVERSE MOMENTUM OF SECONDARY PARTICLES IN HIGH ENERGY COLLISIONS. Rengarajan, T. N. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 56: 153-73(Sept. 1967).

An isobar model in which collision between two particles leads to the creation of only two bodies which by subsequent decay give rise to the observed secondaries was considered. On the basis of such a model, the charge ratios of pions, kaons and Σ-hyperons in p−p and π−p collisions were computed and compared with the available experimental data. Some features of transverse momentum of pions and protons in 24 GeV/c p−p collisions were also studied. (J.F.P.)

13769 MODEL FOR LOW-ENERGY KAON–NUCLEON SCATTERING. Ferreira, Erasmo M. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro. Univ. Catolica, Rio de Janeiro); Lacaze, Robert. Notas Fis., Cent. Brasil. Pesqui. Fis., 13: 139-45(1967).

An effective Lagrangian is proposed for low-energy K + N scattering. This Lagrangian does not include a possible direct exchange of S ≈ +1 baryons, since these are not well established. It also limits the contributions of crossed terms to the Λ and Σ exchanges, neglecting isobar contributions (Y_1^* and Y_1^* exchanges). The values used for the coupling constants are those obtained by Wong and Scotti. Only contributions of ρ, ϕ, and ω exchanges are considered. Attention is called to the fact that there are no free parameters in the calculation. The values of the s-wave scattering lengths, the effective ranges, and the p-wave scattering lengths are listed. Figures obtained using a pure vector-boson dominance model, and using a model consisting of vector boson exchange, including Λ and Σ crossed terms, and contact terms are presented. From the results given it is concluded that although it would seem that a pure vector meson exchange model describes the available data reasonably well, on the other hand by introducing Σ and Λ exchange together with the corresponding contact terms, some smaller or less well-known parameters are undesirably altered, although the s-wave scattering lengths are not affected. This may indicate that inclusion of contributions corresponding to Y_0^* and Y_1^* exchanges should be included when better data are available. (J.F.P.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 13744, 13768, 13865, and 13869.

13770 (JINR–P2-3604) VNUTRIYADERNYE KASKADY S MNOGOCHASTICHNYMI VZAIMODEISTVIYAMI. (Intranuclear Cascade With Many-Particle Interactions). Artykov, I. Z.; Barashenkov, V. S.; Eliseev, S. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 35p. (In Russian). Dep.

The cascades, initiated in various nuclei by mesons and nucleons of an energy from several GeV to about 10^3 GeV, are considered using the Monte−Carlo method. It was taken into account that several particles, produced in foregoing acts of interaction, can interact simultaneously with an intranuclear nucleon. The account of such many-particle interactions is quite necessary to explain the experiments in the energy range T ≳ 100 GeV, where these interactions are several dozens of percent. For T ≈ 10 GeV the fraction of many-particle interactions is also rather essential (in photoemulsion ≈20%). However, the average characteristics of pion-nucleus and nucleon−nucleus interactions are weakly affected. Information on the angular and energy distributions of particles, produced in many-particle interactions, is obtained. These distributions of particles, produced in many-particle interactions, are obtained. These distributions are qualitatively very similar to the corresponding distributions from inelastic pion−nucleon interactions. The process of evaporation of particles from an excited nucleus, formed after passing the intranuclear cascade, is considered. (auth)

13771 (JINR-P2-3619) FENOMENOLOGICHESKII ANALIZ UPRUGOGO RASSEYANIYA π + d → π + d. (Phenomenological Analysis of Elastic π + d → π + d Scattering). Doan Nhuong (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 9p. (In Russian). Dep.

A complete set of measurements (of differential cross section and polarized deuteron effects in a final state) for a direct reconstruction of an elastic π + d → π + d scattering amplitude is suggested. (auth)

13772 (UCRL-17980) MULTI-REGGE APPROACH TO HIGH-ENERGY PRODUCTION PROCESSES. Bali, Naren F.; Chew, Geoffrey F.; Pignotti, Alberto (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1967. Contract W-7405-eng-48. 17p. (CONF-680103-4). Dep. CFSTI.

From Conference on High-Energy Collisions of Hadrons, Geneva, Switzerland.

The production of several uncorrelated particles especially in the high-energy region is considered. Recent work is summarized, and a detailed model for production processes is proposed. As an example a preliminary calculation for the proton−proton case is shown. This example illustrates certain basic features of the model. (J.F.P.)

13773 ANALYSIS OF PROTON–PROTON SCATTERING AT HIGH ENERGY. Kanada, Hiroyuki (Nagoya Univ., Japan); Otsuki, Shoichiro; Sakai, Kenji; Yasuno, Masaru. Progr. Theor. Phys. (Kyoto), 38: 1134-45(Nov. 1967).

Phenomenological analysis of proton-proton elastic scattering above a few GeV/c is made in order to have the idea as to whether the strong repulsive core exists or not at such high energy and how strong the repulsive core can be if it exists. The simplified assumption is made that the nucleon-nucleon interaction is described by a short range repulsive core surrounded by a rather long range absorptive medium and the scattering amplitude is calculated by the distorted wave Born approximation. The analysis is performed in two cases: (1) The repulsive core is described by a hard core. (2) It is described by a soft core of the Gaussian shape. It is quite difficult to explain the high energy data without modifying the strong repulsive core established at low energy. (auth)

13774 KINEMATICAL CONSIDERATIONS ON THREE-PION-EXCHANGE CONTRIBUTIONS IN NUCLEON–NUCLEON SCATTERING. Furuichi, Susumu (Rikkyo Univ., Tokyo); Yonezawa, Minoru. Progr. Theor. Phys. (Kyoto), 38: 1200-2(Nov. 1967).

A preliminary discussion is given on the three-pion-exchange effects in nucleon-nucleon scattering in the intermediate region, and on how these effects could compete with the two-pion effects. The possible classification of three-pion states is discussed, considering only the possible states of the 3π ⇔ $N\bar{N}$ process. The question of whether the ω meson could effectively represent the three-pion exchange effects is considered. (L.B.S.)

13775 PION–NUCLEAR FORWARD DISPERSION RELATIONS. Ericson, T. E. O.; Formanek, J.; Locher, M. P. (CERN, Geneva). Phys. Lett., 26B: 91-4(Dec. 25, 1967).

Forward dispersion relations are applied to $\pi^{12}C$ (and π^4He) elastic scattering. The unphysical region is estimated to have small influence. From $\pi^{-9}Be$ scattering we find an effective π^9Be coupling constant of order $(f^2)_{eff} \approx 0.06$. (auth)

13776 SUPPRESSION OF REGGE CUTS AT t = 0 DUE TO UNIVERSALITY OF FACTORIZED RESIDUES. Horwitz, L. P. (State Univ. of New York, Stony Brook); Ne'eman, Y. Phys. Lett., 26B: 88-90(Dec. 25, 1967).

The contribution of the two-ρ cut to the partial wave amplitude for N-N scattering is examined. It is shown that a significant contribution from cuts at t = 0 would be inconsistent with the universality prescription followed by factorized residues of the Regge poles. It is conjectured that these cut residues simply vanish in the forward direction. (L.B.S.)

13777 THE ONE PION EXCHANGE CONTRIBUTION TO THE WEAK PARITY VIOLATING NUCLEON–NUCLEON POTENTIAL. McKellar, B. H. J. (Inst. for Advanced Study, Princeton, N. J.). Phys. Lett., 26B: 107-8(Dec. 25, 1967).

The one pion exchange contribution to the weak parity violating nucleon-nucleon potential is calculated by relating the weak NNπ vertex to the nonleptonic hyperon decays by the Suzuki−Sugarawa method. It is also shown that the G parity odd part of the weak Hamiltonian cannot contribute to the potential. (auth)

13778 ON THE FLUCTUATION MECHANISM OF HIGH-ENERGETIC ^3H AND ^3He EMISSION IN NUCLEAR SPLITTINGS. Takibaev, Zh. S.; Toktarov, K. A. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 6: 1015-18(Nov. 1967). (In Russian).

The fluctuation mechanism of the emission of high-energetic fragments ($E_{kin} \sim 2$ GeV) from the photoemulsion nuclei was considered. Using the wave functions for ^3H and ^3He proposed by Feshbach and Bethe, the probability of substructure production as well as the cross section of the fragments emission was obtained. The calculations show that the probability of finding the nucleon system in the strong interaction field is approximately an order of magnitude higher than in the data previously obtained. It is concluded that one fluctuation channel cannot explain the emission process even of few-nucleon high-energetic formations. (auth)

13779 STRUCTURE OF HIGH-ENERGY, LARGE-MOMENTUM-TRANSFER COLLISION PROCESSES. Abarbanel, H. D. I.; Drell, S. D.; Gilman, F. J. (Stanford Univ., Calif.). Phys. Rev. Lett., 20: 280-3(Feb. 5, 1968). (SLAC-PUB-371).

It was previously argued that a qualitative connection should exist between high-energy, large-momentum-transfer proton-proton scattering and the structure of the proton as revealed in elastic electron-proton scattering at large momentum transfers. A suggestion is made for the origin of this connection based on the idea that, in hadron processes, under a "diffractive tail" a contact interaction of a current-current nature should emerge with the same currents whose transition form factors are measured in weak and electromagnetic processes. Some implications of the suggestion for future experiments are also presented. (L.B.S.)

13780 PROTON NUCLEAR CROSS SECTIONS AT 20 GeV. Steenberg, N. R. (Univ. of Toronto). pp 195-216 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

An account is given of computer computations for proton–nuclei elastic scattering. The differential cross section for quasi-elastic scattering, the absorption cross section, and the scattering cross section are determined. Diffraction and its analytic application to a nucleus in the heuristically reviewed. The computational program is described, and the results are given. (J.F.P.)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 13236, 13685, 14033, 14084, and 14106.

13781 (ITF-67-17) ON DECOMPOSITION OF IRREDUCIBLE REPRESENTATIONS OF SEMISIMPLE LIE GROUP INTO REPRESENTATIONS OF ITS SEMISIMPLE SUBGROUP. Klymyk, A. U. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 32p. Dep.

The problem of the decomposition of irreducible (finite-dimensional and some infinite-dimensional unitary) representations of a semisimple Lie algebra into representations of its semisimple subgroup is considered. The decomposition of unitary representations of the maximal-degenerate series for the complex unimodular group A_l and the complex symplectic group C_l into the representations of the like subgroup is given. (J.F.P.)

13782 (JINR-E2-3625) RECURSION RELATION FOR THE 3-j SYMBOLS. Miku, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 9p. (In Russian). Dep.

The realization of the SU(2) group by boson operators gives a simple definition for the 3-j symbols as a scalar product for states with three different bosons. Manipulation of the boson operators from one part of the scalar product to another gives recursion relations for the 3-j symbols. By taking into account the symmetries of the 3-j symbols there are six independent recursion relations but this number is reduced to two by the new symmetries discovered by Regge. (auth)

13783 (JINR-P4-3602) O VOZMOZHNOSTI PARAPOLEVOGO PREDSTAVLENIYA VNUTRENNIKH STEPENEI SVOBODY TIPA IZOSPINA I STRANNOSTI. (On a Possibility of Parafields Representation of the Inner Degree of Freedom of the Isospin and Strangeness Type). Govorkov, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 21p. (In Russian). Dep.

A possibility is shown of introducing the inner degrees of freedom of the isospin and strangeness type on the basis of the para-commutation Green–Volkov relations. For this purpose it is suggested that all the irreducible (separable) representations of parafermion relations of the second and the third order be considered, and then different inner states of paraparticles be interpreted as the states belonging either to different irreducible representations or to those which differ by the symmetry of the vector state indices. In the case of the second order an explicit matrix transformation from the parafield to the system of two usual fields (obeying the "isotopic" symmetry) is given. Within the framework of the parafield theory an electromagnetic interaction, violating the symmetry, is introduced. In the case of the third order the mentioned classification of the particle states coincides with that according to "strangeness" and "isomultiplets." (auth)

13784 SYMMETRY GROUP ISL(6) AS A COVARIANT GENERALIZATION OF THE SU(6) GROUP. Kadyshevskii, V. G.; Muradyan, R. M.; Tavkhelidze, A. N.; Todorov, I. T. pp 377-89 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

To eliminate conflicts with experimental data, particularly as far as spin transformations are concerned, a 106-parameter ISL(6) group was postulated that contains the SU(6) group and the Poincaré group P of space–time motions. The inhomogeneous group SL(6) designated as ISL(6) is defined as a covariant generalization of the SU(6) group and its properties are determined. The simplest equations (those for the ½ spin) are invariant with respect to the ISL(6) group; they can be broken up into a system of first-order equations and one of the fifth order, with the whole system not being invariant with respect to reflection transformation. The Lie algebra of the ISL(6) group is studied and the infinitesimal representations of this group considered. All Casimir operators are determined. (JPRS)

13785 INCOMPATIBILITY OF THE RELATIVIZED SU(6) SYMMETRY WITH UNITARITY. Marinov, M. S. pp 390-8 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

The considerable success achieved by applying the hypothesis that strong interactions do not depend on the spin and unitary spin—i.e., the SU(6) symmetry—in the treatment of particle mass spectra and also of peak functions at a zero transmitted momentum (this refers to electromagnetic and weak peak functions) suggests that it would be of advantage to use the same approach in the study of more complex phenomena, primarily those involving form factors at any value of transmitted momentum and two-particle reactions. For this purpose, it would be necessary to find a relativistically invariant scheme that is transformed into ordinary SU(6) symmetry at its statistical limit. In other words, the SU(6) symmetry must be relativized and a theory developed that will make it possible to derive supersymmetric amplitudes for interactions between relativistic particles. Attempts that have been made in this direction have led to results that conflicted with unitarity, analyticity, and the symmetry crossing principle. Apparently a supersymmetric scheme that does not conflict with fundamental principles is much more complex than has been assumed. (JPRS)

13786 AN INHOMOGENEOUS SL(6) GROUP WITH AN EXPANDED SUBGROUP OF TRANSLATIONS. Kadyshevskii, V. G.; Todorov, I. T. pp 399-405 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

In previous work by Kadyshevskii et al. (Voprosy Fiziki Elementarnykh Chastits, Erevan, 377-89(1966)) the ISL(6) group was postulated. This is a minimal group that contains the Poincaré group P and the SU(6) group. Consideration of the simplest invariant equations for free fields indicated that this minimum expansion of SU(6) is not quite satisfactory, because it leads to equations of a higher order which furthermore (in the case of a spinor field) are noninvariant with respect to the reflection. It is possible to introduce a new group P_u with the same homogeneous part, i.e., SL(6), but a more extensive subgroup of translations in such a manner that the simplest P_u-invariant equations are of the first order and do not change upon reflection. P_u retains all the attractive features of ISL(6); specifically, SU(6) enters into it as a small subgroup. The purpose of the introduction of P_u was so far only the solution of the single-particle problem involved in the classification of strongly interacting particles and the study of relations between their characteristics. A different approach with respect to the theory of symmetry will be required in problems involving scattering of particles. (JPRS)

13787 SU(6) AND EXPERIMENTAL DATA. Shekhter, V. M. pp 459-76 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

In SU(6) symmetry the spin is separated from the orbital moment. Thus, generally speaking, this symmetry does not make sense and can be expected to apply only to a limited number of phenomena under special conditions. Consideration of experimental data on SU(6) and related models indicates that SU(6) in all variants describes accurately the low levels such as the baryon multiplet 56 and the meson multiplet 35 or 36. For states with a higher spin, a systematization that is successful to any degree cannot be carried out. An unsophisticated quark model with increasing weight of the strange quark describes most consistently the masses of hadrons. The good agreement between requirements for the hybrid group H and experimental data on form factors and decay processes indicates that as a statistical limit the symmetry $U(6) \times U(6)$ applies rather than SU(6) alone. The symmetry group $U(6) \times U(6)$ contains as subgroups both SU(6) and H. A strange situation exists with respect to the SU(6) hypothesis. Often a good theory, e.g., that postulating CP invariance, does not agree with

experimental data. The opposite applies to the SU(6) symmetry: a sensible theory is lacking, but there is on the whole excellent agreement with experimental facts. (JPRS)

13788 FUNDAMENTAL MULTIPLETS. Ramakrishnan, Alladi (MATSCIENCE, Madras). pp 85-92 of Symposia on Theoretical Physics. Vol. 5. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

Some peculiarities of the Gell-Mann-Nishijima relation in a multiplet structure of elementary particles are pointed out. All possible G-N relations are deduced under the assumption of the SU(2) structure for the multiplets. The implications of these relations for SU(3) symmetry are then discussed with reference to a fundamental triplet which reveals all the peculiarities in a striking manner. The study of higher representations is then considered. (L.B.S.)

13789 ON THE CONFORMAL GROUP AND ITS EQUIVALENCE WITH THE HEXADIMENSIONAL PSEUDO-EUCLIDEAN GROUP. Baktavatsalou, M. (Institut Henri Poincare, Paris). pp 139-44 of Symposia on Theoretical Physics. Vol. 5. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

A study is made of the conformal group and its connection with the six-dimensional pseudo-Euclidean group SO(2,4) by using the known results on the representations of SO(2,4). (L.B.S.)

13790 CONTRACTIONS OF LIE GROUPS AND LIE ALGEBRAS. Venkatesan, K. (MATSCIENCE, Madras). pp 167-79 of Symposia on Theoretical Physics. Vol. 5. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

It is investigated in what sense some Lie groups can be considered as limiting cases of other Lie groups and how their representations can be studied from the representations of the groups of which they appear as limits. An attempt is made to find the conditions under which such a limit exists; for this purpose Lie algebras are used rather than the groups. (L.B.S.)

13791 ISOSPIN SYMMETRY, TCP, AND LOCAL FIELD THEORY. Carruthers, P. (Univ., Rome). Phys. Lett., 26B: 158-60(Jan. 8, 1968).

The C, P, and T transformations are studied for free fields of spin S and isospin I. For self-conjugate fields the square of TCP = Θ is independent of the order of the operators and is $(-1)^{F_S+F_I}$ where F_S, F_I are the fermion number and isofermion number. For pair conjugate fields Θ^2 is in general an order-dependent gauge transformation. (auth)

13792 SOME RESULTS ON THE GROUPS SU(2) AND SU(3). Majumdar, S. Datta (Indian Inst. of Tech., Kharagpur). Progr. Theor. Phys. (Kyoto), 38: 1176(Nov. 1967).

An expression for the Clebsch-Gordon series of SU(2) is given which can be used for studying the SU(3) group. In addition, it is pointed out that certain relations between contiguous Clebsch-Gordon coefficients of SU(2) are also found to be helpful for studying the SU(3) representations. (L.B.S.)

13793 SU(3) CHIRAL DYNAMICS. Minamikawa, Toshiyuki; Miyamoto, Yoneji (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 38: 1195-6(Nov. 1967).

An attempt is made to construct chiral SU(3) dynamics following Weinberg's and Schwinger's recently proposed concept of chiral invariance. (L.B.S.)

13794 MATRIX ELEMENTS OF THE LORENTZ GROUP UNITARY REPRESENTATION. Verdiev, I. A.; Dadashev, L. A. (Inst. of Physics, Baku). Yadern. Fiz., 6: 1094-9(Nov. 1967). (In Russian).

System of differential equations for the matrix elements of the Lorentz group unitary representation and recurrent relations for the matrix elements of Lorentz transformation are obtained. (auth)

13795 ALGEBRA DENSITIES AND FORM FACTORS. Efremov, A. V.; Stepanov, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1070-2(Nov. 1967). (In Russian).

It is shown that the covariant formulation of the current density algebra in the case of restriction in the intermediate state by the same multiplet as the initial and final one results in the equation system for form factors with only trivial solution, i.e., normal form factors are identically equal to unit and anomalous ones to zero. (auth)

13796 INFINITE-DIMENSIONAL REPRESENTATIONS OF THE ROTATION GROUP. Sannikov, S. S. Yadern. Fiz., 6: 1084-93(Nov. 1967). (In Russian).

The continuous series $D(\lambda,\nu_0)$ of the infinite-dimensional irreducible representations of the rotation group R_3 is constructed. These representations are characterized by two quantum numbers. Classification of all the irreducible nonequivalent R_3 group representations is given. Analytical relation between the representations of the group R_3 and the Lorentz group L_3 is shown. Representations of the continuous series $D(\lambda,\nu_0)$ are constructed in the complex variable analytical functions realization. The expressions for the matrix elements of these representations were found. The representations are realized by the nonlimited operators in linear topological spaces. (auth)

13797 EXACT DETERMINATION OF THE GAMOW-TELLER MATRIX ELEMENTS FOR SUPERMULTIPLET STATES. Kushner, M.; Quintanilla, J. (Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis., 16: 251-81(1967).

The explicit expression of the Gamow-Teller operator $\sigma_q\tau_4$ in terms of the generators of the unitary group of 4 dimensions U_4 associated with spin-isospin was given by Moshinsky and Nagel. One can therefore determine the matrix elements of the generators of U_4 with respect to states $|(v_1v_2v_3v_4)\ \beta STM_SM_T\rangle$ where $(v_1v_2v_3v_4)$ is the irreducible representation (IR) of U_4, STM_SM_T are, respectively the spin, isospin, and their projections, and β indicates some extra quantum numbers. The latter matrix elements can be obtained using the result of Gelfand and Zetlin for the matrix elements of the generators of U(4) for states characterized by a canonical chain of subgroups then obtaining the transformation brackets between the canonical chain and the states 1. The last step is carried and thus the procedure for determining the matrix elements of the Gamow-Teller operator with respect to supermultiplet states is exact. (auth)

13798 ELEMENTARY INTRODUCTION TO SYMMETRY GROUPS AND ALGEBRA OF CURRENTS. Nuyts, Jean (Inst. for Advanced Study, Princeton, N. J.). pp 1-77 of Lectures in Theoretical Physics. Vol. IX A. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

A review is given of symmetry groups and current algebra starting from earlier premises and giving a few examples of the various situations. The description is phenomenological in that a brief discussion of some properties of strong, weak, and electromagnetic interactions and relations between them is given. The theorems and results quoted are not proven, but some indications are presented to make them appear plausible. Internal symmetries, combination with the Poincare group, and current algebra are covered. (J.F.P.)

13799 UNIFIED ALGEBRAIC CONSTRUCTION OF REPRESENTATIONS OF COMPACT AND NONCOMPACT LIE ALGEBRAS AND LIE GROUPS. Barut, A. O. (Univ. of Colorado, Boulder). pp 125-71 of Lectures in Theoretical Physics. Vol. IX A. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

An elementary account of explicit algebraic construction of unitary representations of a number of compact and noncompact groups and a discussion of related group theoretical problems are presented. The representations of the higher groups are constructed on the spaces of irreducible representations of smaller subgroups. The compact and noncompact groups distinguished by the values of some parameters are discussed simultaneously to show where the differences and similarities arise. The emphasis is on the explicit working out of representations; the general theorems are mentioned during the discussion. (J.F.P.)

13800 DECOMPOSITIONS OF DISCRETE MOST DEGENERATE REPRESENTATIONS OF $SO_0(p,q)$ WHEN RESTRICTED TO REPRESENTATIONS OF $SO_0(p,q-1)$ OR $SO_0(p-1,q)$. Niederle, J. (International Atomic Energy Agency, Trieste, Italy). J. Math. Phys. (N. Y.), 8: 1921-30(Sept. 1967).

The decomposition of any most degenerate unitary irreducible representation (single-valued of discrete principal series) of an arbitrary noncompact rotation group $SO_0(p,q)(p \geq q > 1)$ when restricted to the unitary irreducible representations of its maximal noncompact rotation subgroup $SO_0(p,q-1)$ or $SO_0(p-1,q)$ is derived, and characteristic features of the decomposition are discussed. (auth)

13801 AN EXPERIMENTAL REVIEW OF SU(3). Leitner, J. (Syracuse Univ., N. Y.). pp 19-54 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

A review of SU(3) agreement with experiment is given. The assumptions are listed and discussed, and various experiments are considered. A critical review of the successes and failures together with the assumptions involved in each experiment is presented. The two major problems which appear to confront SU(3) are the disagreements in production rate predictions at low Q and the p-wave hyperon decay problem. It is considered that the apparent success of SU(3) regarding hadron classification is the

strongest indication that SU(3) will remain a part of whatever more comprehensive theory eventually evolves. (J.F.P.)

13802 DYNAMICAL GROUPS AND A CRITERION OF ELEMENTARITY. Barut, A. O. (Univ. of Colorado, Boulder). pp 273-7 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

A criterion of elementarity is proposed in terms of the possible states of the system (without reference to space–time properties or local fields). From these considerations it is deduced that the baryons form a composite system with the proton as the ground state. But the meson states are connected to lepton states, thus they would not be a separate system. (J.F.P.)

13803 INTERNAL DYNAMICS OF MESONS AND BARYONS. Sinanoglu, Oktay (Yale Univ., New Haven). pp 313-26 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

The group theoretic classification of mesons and baryons at rest with respect to their quantum numbers and masses is considered. First a purely phenomenological examination is made of several possible assignments that were considered previously for higher hadron levels. Then the possible noncompact degeneracy or invariance subgroup is interpreted. An attempt is made to see which noncompact groups are most likely on the basis of the known hadrons. Finally, mass formulas for splittings within multiplets are considered. (J.F.P.)

13804 DYNAMICAL GROUP OF A SIMPLE PARTICLE MODEL. Bohm, A. (Syracuse Univ., N. Y.). pp 327-36 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

The assumption is made that the basic physical quantities are generators of an associative algebra a of linear operators in the linear space of physical states and that $\epsilon(G) \subset a$. The algebra of the model is generated by the P_μ, B_μ, $L_{\mu\nu}$ and $(P_\mu P^\mu)^{1/2} L_{\mu,\nu} = 0, 1, 2, 3)$, where P_μ and $L_{\mu\nu}$ have the usual physical interpretation, and the B_μ is called dynamical momenta. (J.F.P.)

13805 THE POSSIBILITY OF R(11). Joseph, D. W. (Univ. of Nebraska, Lincoln). pp 337-50 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

The multiplet structure of R(11) is briefly reviewed, and a previous calculation is discussed. It is noted that if the complexities of R(11) with regard to particle spectra are overlooked and the predictions from the currents are checked, a number is obtained which is in exceedingly good agreement with experiment. (J.F.P.)

13806 NEW REPRESENTATIONS OF THE LIE ALGEBRA OF THE ROTATION R_3 GROUP. Sannikov, S. S. Yadern. Fiz., 6: 1294-1307(Dec. 1967). (In Russian).

Complete classification of all possible representations for the angular momentum operators of the R_3 group is given. All the irreducible and partially reducible representations are obtained. Some concrete realizations of the constructed representations are considered. In the realization by means of functions on the sphere the formula of completeness of the obtained irreducible representations is deduced. The question about the introduction of various topologies in the carrier space is discussed. (auth)

13807 INTEGRAL REPRESENTATIONS FOR RELATIVISTIC AMPLITUDES AND ASYMPTOTIC THEOREMS. Kuznetsov, G. I.; Smorodinskii, Ya. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1308-12(Dec. 1967). (In Russian).

Consequences following from the existence of expansion of the amplitudes in the functions realizing the infinite-dimension unitary representations of the Lorentz group are considered. These are: integral representations of asymptotic amplitudes are given; the equality of particle-antiparticle scattering amplitude modules at a nonzero scattering angle is shown. (auth)

13808 FIBRE BUNDLE C(N) AND CONNECTION OF $SU(2)_J$ AND SU(N) SYMMETRIES. Mozrzymas, J. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 529-31 (1967).

A formulation of the nonrelativistic Rzewuski model in terms of the theory of fibre bundles is presented. This bundle is denoted by $C(N) : C(N) = (E_3, SU(N))$, where the three-dimensional Euclidean space E_3 (subspace of Minkowski's space–time) and the internal symmetry group SU(N) are assumed to be the base space and group of the bundle respectively. (J.F.P.)

13809 QUASIQUARKS AND CROSS-SECTIONS OF THE BUNDLE C(N). Mozrzymas, J. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 533-6(1967).

It is noted that in the previous formulation of the nonrelativistic Rzewuski model in terms of the theory of fibre bundles the cross sections of the bundle C(N) are covariant with respect to $SU(2)_J$ (spin) but they are not covariant with respect to SU(N) (internal symmetry). This broken internal symmetry is regarded as a result of the existence of some interaction which is assumed to be a consequence of the connection of $SU(2)_J$ and SU(N) symmetries by means of the bundle C(N). A previously formulated method is used to determine the potential of this interaction. As a result the Coulomb potential is obtained, and the possibility of introducing particles with nonintegral electric charges is found. These particles are called quasiquarks. In the case where N = 3 (the bundle group is SU(3)) three quasiquarks are obtained. Two of them have identical charges $Q_1 = Q_2 = Q$, the charge of the third one is $Q_3 = -2Q$. Therefore the ratio of charges is exactly the same for quasiquarks and quarks. Finally, the possibility of obtaining the discrete energy spectrum of a hydrogenlike atom is noted. (J.F.P.)

13810 LEKTSII PO TEORII UNITARNOI SIMMETRII ELEMENTARNYKH CHASTITS. (Lectures on the Theory of Unitary Symmetry of Elementary Particles). Nguyen Van Hieu. Moscow, Atomizdat, 1967. 344p.

Systemized data are presented on the theory of isotropic invariance, unitary symmetry and classifications of elementary particles in SU(2), SU(3), and SU(6) symmetries and the effects of these symmetries in the weak, strong, and electromagnetic interactions. A brief review is also given on the composite elementary particle models and theoretical predictions are compared with the experimental data. 120 references. (R.V.J.)

Applications (Electromagnetic and Weak)

13811 (JINR–P2-3622) OB ODNOI VOZMOZHNOSTI PROVERKI CPT-INVARIANTNOSTI. (On a Possibility of Testing CPT-Invariance). Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 10p. (In Russian). Dep.

The possibility and the sensitivity of the verification of CPT-invariance in the $K^0 \to 2\pi$ decay are considered. (TCO)

13812 POSSIBLE CHARACTERISTICS OF NONLEPTONIC INTERACTIONS VIOLATING CP PARITY. Okun', L. B. pp 9-21 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

The experimental results described by J. H. Christensen et al. in Phys. Rev. Lett., 13: 138(1964) indicate that the decay reaction $K_2^0 \to 2\pi$ takes place with violation of CP parity. This type of nonleptonic reaction may be referred to as an X-interaction. At first glance, the X-interaction considered has CP = −1, P = −1, $|\Delta Y| = 1$ and a constant approximately three orders of magnitude smaller than that of a weak interaction. However, the reaction $K_2^0 \to 2\pi$ may proceed indirectly by $K_2^0 \to K_1^0 \to 2\pi$ and have a measurable amplitude even if that of the direct decay is zero. The amplitude of $K_2 \rightleftharpoons K_1$ satisfies the selection rule CP = −1, P = +1, $|\Delta Y| = 2$. In the amplitudes of $K_2 \rightleftharpoons K_1$ and $K_2 \to 2\pi$, the CP nonparity interaction is not exhibited in an isolated manner, but is disguised by strong, weak, and electromagnetic interactions. This increases the number of variants of the selection rule which can be ascribed to the CP nonparity interaction. The possible selection rules in X-interactions varying with respect to Y and T are discussed. The correctness of various hypotheses arrived at on the nature of the $K^0 \to 2\pi$ decay can be checked on the basis of experimental data pertaining to decay reactions of neutral K mesons, other nonleptonic and leptonic decay reactions, and strong and electromagnetic processes. These experimental data are in part already available. (JPRS)

13813 POSSIBLE C-, T-NONINVARIANCE IN ELECTROMAGNETIC INTERACTIONS. Bernstein, J.; Feinberg, G.; Lee, T. D. pp 22-42 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

The experimental basis of various characteristics of strong and electromagnetic interactions related to discrete symmetries is reviewed. It was established that there is a high probability of noninvariance with respect to P and CPT for both strong and electromagnetic interactions and it is well substantiated that strong interactions are noninvariant with respect to C and T. However, proofs are lacking at present that the electromagnetic interaction of strongly interacting particles is noninvariant with respect to C and T. Noninvariance in electromagnetic interactions can be checked experimentally. If there is a strong deviation from C-, T-noninvariance in electromagnetic interactions of strongly interacting particles, a disturbance of C and CP invariance will be observed in strong and weak processes during 2nd order reactions. Specifically, the decay $K_2^0 \to \pi^+ + \pi^-$ will take place with an

amplitude of $\sim(\alpha/\pi)$ in relation to that of the decay $K_1^0 \to \pi^+ + \pi^-$. (JPRS)

13814 MINIMAL ELECTROMAGNETIC INTERACTION AND C-, T-NONINVARIANCE. Lee, T. D. pp 43-65 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

The problem as to whether a minimal electromagnetic interaction that is noninvariant with respect to C and P may take place is considered. For a system of N particles with spin 1 and the equal charge ϵ, it is brought out that the minimal electromagnetic interaction $L\gamma$ of particles depends on ϵ and the $N \times N$ Hermitian matrix of the magnetic moment M. It is shown that depending on the structure of M and the magnitude of N, $L\gamma$ may be noninvariant with respect to T and C; however, all minimal electromagnetic interactions of this type will be invariant with respect to P and CT. The general conditions for C and T invariance of noninvariance of $L\gamma$ in the absence of strong interactions are formulated. Application of the relations derived to a system of N neutral particles with a spin of 1 indicates that $L\gamma$ of the system must depend only on the antisymmetric $N \times N$ Hermitian matrix of M. Their application to φ^0, ρ^0, and ω^0 mesons leads to the conclusion that $L\gamma$ for these particles must be noninvariant with respect to C and T. (JPRS)

13815 PROPERTIES OF SOME VECTOR CONSTANTS OF β-DECAY WITH A CHANGE IN STRANGENESS. Kobzarev, I. Yu. pp 66-78 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

It has been shown by N. Cabibbo (Phys. Rev. Lett., 10: 531 (1963)) that hadron β-decay processes can be described by a small number of parameters within the framework of SU_3 symmetry. This has been shown earlier by Kobzarev and L. B. Okun' for the decay of mesons (Zh. Eksper. Teor. Fiz., 42: 1400(1962)) and does not conflict with experimental data. However, the Cabibbo description applies only when the SU_3 symmetry is precise, i.e., it is valid in a zero approximation. When deviations from the zero approximation occur, the cleavage of masses and amplitudes of decay may differ considerably from those predicted by the theory. From this standpoint the theorems of M. Ademollo and K. Gatto (Phys. Rev. Lett., 13: 264(1964)) and C. Bouchiat and Ph. Meyer (Nuovo Cim., 34: 1122(1964)) present considerable interest, because they indicate that after certain assumptions have been made, the values of the vector constants predicted by Cabibbo's theory do not change in the first approximation for interactions in which SU_3 symmetry is violated. Under the circumstances an independent determination of the vector constants of decay processes involving strange particles becomes important, because of the problem of applicability of the SU_3 symmetry is particularly critical there. A derivation of the theorems of Ademollo and Gatto and of Bouchiat and Meyer is given and the conditions under which they can be applied are discussed. (JPRS)

13816 EXISTENCE OF AN INTERNUCLEON POTENTIAL THAT DOES NOT PRESERVE SPATIAL PARITY. Krupchitskii, P. A. pp 102-112 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

Soon after the discovery of nonpreservation of parity in weak interactions, the hypothesis in regard to the universal nature of weak interactions was advanced and the theory of universal weak interaction formulated. The universality consists in the fact that all known particles, both hadrons and leptons, exhibit the same capacity for weak interaction and that a certain vector current of weak interaction is preserved which does not depend on the nature of the particles that produce it. Spontaneously interacting currents arise, of which only one, i.e., the $(\bar{n}p)(\bar{p}n)$ current between two nucleons, has been observed experimentally. It is due to the weak interaction and for this reason does not preserve spatial parity. This current is difficult to detect, because it is disguised by strong interactions. The existence of this current and the correct value of its potential in relation to that of strong interactions of the Yukawa type have been established in experiments conducted by Yu. G. Abov, P. A. Krupchitskii, and Yu. A. Oratovskii, (Phys. Lett., 12: 25(1964)) and by F. Boehm and E. Kankeleit (Phys. Rev. Lett., 14: 312(1965)). A study of the isotopic structure of the internucleon potential that does not preserve spatial parity can be carried out by investigating the α-decay of a light nucleus such as ^{16}O (these experiments will be difficult to conduct) or by carrying out an experiment such as that conducted at the California Institute of Technology, but on the light nucleus ^{10}B instead of ^{181}Ta. The problem in regard to the isotopic structure of the potential has been elaborated from the theoretical standpoint by M. Gell-Mann. (JPRS)

13817 CHIRAL DYNAMICS, NONLEPTONIC DECAYS OF K MESONS AND THE DERIVATION OF $\Delta I = \frac{1}{2}$ RULE. Minamikawa, Toshiyuki; Miyamoto, Yoneji (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 38: 1193-5(Nov. 1967).

It is shown that the method recently used by Weinberg for deriving the effective Lagrangian for soft pion interaction, which starts from the σ model for quarks and uses the SU(2) chiral transformation, can also be applied to the weak interaction problem. The validity of the $\Delta I = \frac{1}{2}$ rule is argued and the relation between $K \to 2\pi$ and $K \to 3\pi$ decay amplitude is derived. (L.B.S.)

13818 ELECTROMAGNETIC MASS DIFFERENCE OF KAONS. Cook, C. L.; Evans, L. E.; Han, M. Y.; Lipshutz, N. R.; Straumann, N. (Duke Univ., Durham, N. C.). Phys. Rev. Lett., 20: 295-7(Feb. 5, 1968).

Using the algebra of currents, modified Weinberg sum rules, and the tadpole model of Coleman, Glashow, and Schnitzer, the kaon electromagnetic mass difference was calculated in the soft-kaon limit to be -3.9 ± 0.6 MeV, in excellent agreement with experiment. (auth)

13819 MASS SPLITTING AND NONLEPTONIC S-WAVE DECAYS OF HADRONS IN SU(6) ALGEBRA OF GELL-MANN. Mahanthappa, K. T. (Univ. of Pennsylvania, Philadelphia). pp 351-9 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

The physical information which can be obtained from a set of equal-time commutation relations of various currents which form an algebra is considered. Among the commutation relations discussed are one used to describe mass splitting within a multiplet, and one used to relate mass splittings with nonleptonic S-wave decays of hadrons which permits relations between hyperon decays and meson (K) decays. The theoretical hyperon decay amplitudes are listed and compared with those from experiment. (J.F.P.)

13820 CONDITIONS FOR THE VALIDITY OF THE [WEINBERG] SUM RULES $g_{A_1^+}^2 m_{A_1^+}^{-2} + \frac{1}{2} f_{\pi^+}^{-2} = g_{\rho^+}^{-2} m_{\rho^+}^{-4}$ AND $g_{A_1^0}^2 = g_{\rho^0}^{-2}$. Perrin, Robert (Havard Univ., Cambridge, Mass.). Phys. Rev. Lett., 20: 306-8(Feb. 5, 1968).

It is shown that if the validity of the Jacobi identity for triple equal-time commutators is assumed, then the proof for the sum rule $g_{A_1^0}^2 = g_{\rho^0}^2$ is not affected by the presence of I = 1 Schwinger terms, while the proof of the sum rule $g_{A_1^+}^2 m_{A_1^+}^{-4} + \frac{1}{2} f_{\pi^+}^2 = g_{\rho^+}^2 m_{\rho^+}^2$ requires the assumption that if an I = 1 pseudoscalar Schwinger term exists, then its coupling to the pion is much weaker than that of the axial-vector current. (auth)

13821 DIFFERENCE BETWEEN THE SPECTRA OF K_{l3}^0 and $\bar{K}_{l3}^0$ DECAYS. Okun', L. B. JETP Lett. (USSR) (Engl. Transl.), 6: 272-4(Oct. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 823-5(Oct. 15, 1967).

An expression for the difference between the differential probabilities of $K^0 \to \mu^+ + \nu + \pi^-$ and $\bar{K}^0 \to \mu^- + \bar{\nu} + \pi^+$ decays is derived. This difference should occur if CP invariance is violated in these decays, and is of the order of α Im ξ. The total probabilities of these decays are the same in this approximation. The question of the possible difference between the probabilities for the spectra and angular distributions for the considered decays is discussed. Such a difference should arise if CP invariance is violated. It is noted that for these decays the discussed difference in the spectra should be negligibly small. (J.F.P.)

Applications (Strong)

13822 (PUC-937-285) QUARKS AND SYMMETRIES. Lipkin, H. J. (Weizmann Inst. of Science, Rehovoth (Israel). Princeton Univ., N. J. Palmer Physical Lab.). Sept. 1967. Contract AT(30-1)-937. 18p. (CONF-670934-10). Dep. CFSTI.

From International Conference on Elementary Particles, Heidelberg, Germany.

The discussion of quarks and symmetries covers the basic rules of the quark model, additivity applications, the axial vector mesons (K^*), the present status of SU(3), and that of higher symmetries. The experimental search for quarks is also reviewed. (J.F.P.)

13823 APPROXIMATE SYMMETRIES OF HADRONS. Dashen, R. F.; Dothan, Y.; Gell-Mann, M.; Neeman, Y. pp 341-59 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

Approximate symmetries of hadrons, specifically of moving hadrons, have been discussed extensively recently. The noncompact symmetry group U(6,6) has attracted considerable attention.

Although the scheme using this group violates conservation of probability and leads to results which do not agree with some experimental data, correct values of some constants could be derived on its basis. The predictions made on the basis of this theory are in complete agreement with results obtained without violating the conservation of probability and arrived at by applying symmetry operators to states. Successful predictions of approximate higher symmetry can be made for 36 M mesons and 56 B baryons by employing positive parity U(6) × U(6) algebra for the rough description of the symmetry of quiescent states. Current components with negative parity, the space integrals of which supplement the compact U(12) algebra, can be used to derive the approximate Goldberger–Treiman formula and the rule of magnetic moment sums approximately limited by the lower intermediate states. These results agree with relations that follow from the U(6) × U(6) symmetry. To treat higher meson and baryon multiplets, a new noncompact group must be used that includes a U(6) × U(6) group as a subgroup. (JPRS)

13824 U(6) X U(6) SYMMETRY. Gell-Mann, M. pp 360-8 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

If one assumes that mesons and baryons undergo transformations within the framework of the U(6) × U(6) symmetry in a manner that approximately corresponds to transformations of states composed of quarks ($\bar{Q}Q$ and QQQ, respectively), with the quarks assumed to be in a state of rest, one obtains good agreement between theoretical relations and experimental data for 56-plet baryons and 35-plet mesons and one meson singlet in a motionless state. Correct results on form factors are also obtained by assuming U(6) hybrid groups for the baryon 56-plet and the meson 35-plet for processes taking place in one direction under the action of an impulse. From the relations derived from U(6) × U(6) symmetry, one obtains the correct ratio $G_E^p/G_E^n = -\frac{2}{3}$ of magnetic form factors for a proton and a neutron at any values of the transmitted momentum and the value $G_E^n = 0$ for the electric form factor of a neutron. (JPRS)

13825 SU(6) SYMMETRY. Berestetskii, V. B. pp 369-76 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

A review of the present state of symmetry theory for strongly interacting particles indicates that the SU(6) theory has been very useful in the description of hadron multiplets and has also led to excellent results in the treatment of the relation between the magnetic moments of a proton and a neutron. The SU(6) symmetry applies to single-particle states rather than to interactions; the poles of the S-matrix rather than its elements exhibit symmetry. To eliminate the inconsistencies associated with SU(6), more general groups were postulated for which SU(6) is a nonrelativistic limit. For instance, the U(12) group was formulated and an invariant Lagrangian of the interaction derived. However, one cannot escape the requirements of relativistic invariance. The functions of particle propagation (propagators) violate the symmetry. As a result, a basic conflict with a principal requirement of the quantum theory develops, i.e., that of unitarity and preservation of probability. Thus, SU(6) symmetry is applicable only in a limited sense. (JPRS)

13826 RESULTS PERTAINING TO SU(3). Shekhter, V. M. pp 436-58 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

A review of experimental data from the standpoint of the applicability of unitary symmetry theory indicates that the following facts confirm the correctness of this theory. Hadrons with the quantum numbers 0^-, 1^-, $\frac{1}{2}^+$, and $\frac{3}{2}^+$ are grouped together into unitary singlets, octets, and a decouplet. Hadrons with these quantum numbers that behave differently have not been found. The Gell-Mann–Okubo mass relation is fulfilled for the baryon octet and the $\frac{3}{2}^+$ isobar decouplet. The Ω^- hyperon was found in the exact place predicted. The Coleman–Glashow formula yields a correct value with the correct sign for the $\Xi^- - \Xi^0$ difference. With respect to fulfillment of the quadratic mass relation for the pseudoscalar octet, the results of the application of unitary symmetry were doubtful. Unitary symmetry relations did not apply to nuclear reaction cross sections or partial cross sections of decay; apparently interactions that violate unitary symmetry are of importance in the phenomena in question. (JPRS)

13827 THE $J^P = 1^+$ OCTODECIMET OF MESON RESONANCES. Gatto, R. (CERN, Geneva); Maiani, L. Phys. Lett., 26B: 95-9(Dec. 25, 1967).

Pairs of mixed nonets (octodecimets) of boson resonances with same J^P and opposite C are expected in the quark picture. A general SU_3 analysis is developed and applied to a possible octodecimet of axial-vector mesons. The consistency of possible alternative assignments is discussed. (auth)

13828 $SU(6)_W$ AND COMPOSITE MODELS OF HADRONS. Capps, Richard H. (Northwestern Univ., Evanston, Ill.). pp 77-102 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

A description is given of a combination of the light multiplet hypothesis and the idea that the basic Yukawa interactions are symmetric with respect to $SU(6)_W$. It is shown that this combination is successful and that each idea improves the other. A brief history of the light multiplet hypothesis covering pre-SU(6), SU(6), and $SU(6)_W$ is given with emphasis on the $SU(6)_W$ hypothesis. (J.F.P.)

13829 UNITARY RESTRICTIONS ON SCATTERING AMPLITUDES FROM DYNAMICAL GROUPS. Raman, K. (Syracuse Univ., N. Y.). pp 377-92 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

It is shown that starting with the restriction that groups like U(6,6) should be regarded as a symmetry only of three-point functions and applying a dynamical group directly only to three-point functions, one can obtain restrictions on two-body reaction amplitudes that are consistent with the unitarity of the S-matrix. A method of obtaining restrictions on scattering amplitudes starting with vertex functions is given. The unitary relation for the πNN vertex is considered. It is also shown that by making the additional assumption that in the two-body approximation to the unitarity relation, the partial waves for $\bar{B}B$ annihilation into two mesons are constrained by the SU(3) content of these representations, many more results can be obtained using this method. (J.F.P.)

Field Theories

General

13830 A CLASS OF EIGENVALUES OF THE FINE-STRUCTURE CONSTANT AND INTERNAL ENERGY OBTAINED FROM A CLASS OF EXACT SOLUTIONS OF THE COMBINED KLEIN–GORDON–MAXWELL–EINSTEIN FIELD EQUATIONS. Das, A.; Coffman, C. V. (Carnegie Inst. of Tech., Pittsburgh). J. Math. Phys. (N. Y.), 8: 1720-35(Sept. 1967).

The combined Klein–Gordon–Maxwell–Einstein field equations, which govern completely and self-consistently the spinless, charged, gravitating matter distribution, is studied. One of the theorems that have been proved here states that, from a static, purely gravitational universe, a class of electrogravitational universes containing a stationary matter field can be constructed, provided a single differential equation is satisfied. The construction of the electrogravitational universe from the Schwarzchild solution hinges on the solubility of the ordinary differential equation $U'' + \alpha^2(x\ \mathrm{csch}^2 x)^2U^3 = 0$, where the prime denotes differentiation and α^2 stands for the fine-structure constant. Next, the following nonlinear eigenvalue problem related to this differential equation has been posed. Are there some positive values of α corresponding to which solutions $U(x)$ exist such that (i) U is analytic and positive in $x \in (0, \infty)$(→ the volume element has one sign), (ii) $U(0) = 0$ (this condition is physically unpleasant but forced by the differential equation itself), (iii) $U'(\infty) = 0$ (→ no force at the center of spherically symmetric mass and charge distributions), (iv) $U'(0) = \alpha$ (→ the total charge of the material distribution is α)? The answer is "yes" and it has been rigorously proved that there exists a unique solution of the problem. The corresponding value of α comes out to be 1.4343 $(\hbar c)^{\frac{1}{2}}$, which, unfortunately, does not agree with the experiment (the discrepancy may be attributed to the neglect of the second quantization). If the restriction in $U(x)$ to be positive is withdrawn, then a countable number of solutions exist with the corresponding eigenvalues for the electronic charge, internal energy, and mass. These solutions give rise to universes which are topologically inequivalent to Euclidean space and contain a finite number of shells. It should be mentioned that the present eigenvalue problem appears as a consequence of the "Weyl–Majumdar" condition on the electrogravitational universe. There may well exist other eigenvalue problems for the fine-structure constant within the framework of the Klein–Gordon–Maxwell–Einstein field equations without the "Weyl–Majumdar" condition. "... es kann dann in jedem Punkte das Krümmungsmass in drei Richtungen einen beliebigen Werth haben, wenn nur die

ganze Krümmung jedes messbaren Raumtheils nicht merklich von Null verschieden ist..." — Riemann. (auth)

Quantum Field Theory

Refer also to abstracts 13685, 13712, 13791, and 13857.

13831 (ITF-67-27) PROBLEMY DINAMICHESKOGO APPARATA KVANTOVOI TEORII POLYA V AKSIOMATICHESKOM METODE. (The Problems of Dynamical Apparatus of Quantum Field Theory in Axiomatic Method). Medvedev, B. V.; Polivanov, M. K.; Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 31p. (In Russian). (CONF-670544-1).

From Conference on Axiomatic Quantum Field Theory and Elementary Particles, Kiev, USSR.

The proof is given of Wick's theorem interrelating quasi-normal and common powers of Heisenberg fields, which is valid for a certain class of theories. On the basis of this theorem a method is developed to determine, in renormalizable theories, the higher current-like operators Λ_n, with the current operator given as a local function of Heisenberg fields. The operators Λ_n are shown to play an important dynamical role, especially in the case where they involve derivatives of δ-functions. (auth)

13832 (ITF-67-28) PERENORMIROVKA POLYA V AKSIOMATICHESKOI KVANTOVOI TEORII. (Field Renormalization in Axiomatic Quantum Theory). Medvedev, B. V.; Polivanov, M. K.; Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 19p. (In Russian). (CONF-670544-2).

From Conference on Axiomatic Quantum Field Theory and Elementary Particles, Kiev, USSR.

The method of renormalization of field operators developed earlier by means of a model is applied to the realistic theory in which the S-matrix depends on the starting Lagrangian as well as on the renormalization counter term. The renormalization of Heisenberg field and current operators is achieved. The renormalization factors turn out to be integral operators of a special kind. The vertex operator is represented in the same way. The renormalization changes the argument-function (off the energy shell) of all Heisenberg operators. The method characterized above enables one to overcome some difficulties arising when the nonlinear condition integrability is renormalized in Bogoliubov's axiomatics. (auth)

13833 (ITF-67-29) SPEKTRAL'NYE PREDSTAVLENIYA I PERENORMIROVKA POLYA. (Spectral Representations and Field Renormalization). Medvedev, B. V.; Polivanov, M. K.; Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 22p. (In Russian). (CONF-670544-3).

From Conference on Axiomatic Quantum Field Theory and Elementary Particles, Kiev, USSR.

The technique developed in previous papers is applied to interrelate two methods of introducing the renormalization constants, namely, the Hamiltonian and axiomatic ones. The form of spectral representations is shown to depend essentially on whether subtractions were made or not. In the presence of subtractions the final form of spectral representations is obtained by a kind of one-particle condition of unitarity. Strictly following the procedure one can interrelate renormalized and nonrenormalized quantities of the Lagrangian and axiomatic formalisms as well as establish the self-consistency of the results for Heisenberg operators and their expectation values. (auth)

13834 (JINR-E2-3610) ANALYTIC CONTINUATION IN THE COUPLING CONSTANT IN THE NONRENORMALIZABLE FIELD THEORY MODEL. Arbuzov, B. A.; Atakishiev, N. M.; Filippov, A. T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 15p. Dep.

A method is developed for constructing the exact solution of the Dyson equation in the nonrenormalizable field theory with the interaction Lagrangian $L_{int} = g\bar{\psi}\gamma_n\psi\partial^n\phi$, ψ and ϕ being spinor and scalar fields respectively. The method is based on the analytic continuation in the coupling constant g, the necessity for which being tightly connected with an exponential singularity of the spinor Green function in the complex momentum plane at infinity. This singularity does not violate the conditions of the localizability of the theory. The method is applicable to more realistic field theories. (auth)

13835 (NP-17207) CALCUL DES CORRECTIONS RADIATIVES JUSQU'AU SIXIEME ORDRE INCLUS POUR LE MODELE $\lambda\phi^3_6$. (Calculation of Radiative Corrections to the Sixth Order Inclusive for the $\lambda\phi^3_6$ Model). Calmet, Jacques (Aix-Marseilles Univ. (France). Faculte des Sciences). Dec. 19, 1966. 86p. Dep.

Thesis.

The $\lambda\phi^3_6$ model, which although possessing formal analogies with electromagnetism does not have physical volume, was studied. The results of the study of the renormalization in functional formalism are presented with all of the results given in pulse space. The graphic method used and the writing of the first six approximations of the finite part of the functional generator of the propagators are reported. The calculations made by Soffer were redone and verified. The finite part of the contribution of the divergent graph of the second order is calculated and its most important properties determined. The contributions of the graphs pertaining to the third, fourth, fifth, and sixth orders are calculated. The principle used — iteration method of approximations — is developed for the fourth order and the steps were simply indicated. The results obtained are compiled and tabulated. (J.S.R.)

13836 (SU-1206-131) INDEFINITE METRIC AND NON-LOCAL FIELD THEORIES. Sudarshan, E. C. G. (Syracuse Univ., N. Y. Dept. of Physics). Oct. 1967. Contract AT(30-1)-3399. 39p. (NYO-3399-131; CONF-671049-1). Dep. CFSTI.

From 14th Solvay Conference, Brussels, Belgium.

A meaningful relativistic quantum field theory with local interactions in an indefinite metric space is developed. The theory yields transition amplitudes which have some superficial resemblance to those obtained by regularization but they are essentially distinct. The mathematical structure of the theory is different from that of the field-theoretic version of regularization. The question of identification of the physical probability amplitudes is considered and solved. (J.F.P.)

13837 APPLICATION OF ALGEBRAIC TOPOLOGY TO FEYNMAN INTEGRALS. Teplitz, V. L. (Massachusetts Inst. of Tech., Cambridge). pp 29-50 of Symposia on Theoretical Physics. Vol. 5. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

The application of homology theory to the study of the singularity structure of integrals like the Feynman and unitary integrals is discussed. The homology groups are first computed for a few geometrical figures. The notions of vanishing cycle, Kronecker index, and Leray's coboundary operator is introduced by discussing a simple example. The singularity structure of an integral is then analyzed in a more general setting. Finally, the results are applied to the case of a two-particle unitary integral for a production amplitude. (L.B.S.)

13838 DEGENERATE VACUUM AND THE INFINITE COMPONENT WAVE EQUATION. Goto, Tetsuo (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 38: 1168-75(Nov. 1967).

In the field theoretical viewpoint, an infinite component wave equation, which is of first order in p_μ, is derived for the one-particle wave function. The mass formulas are as follows: $m = \mu_0(J + 1/2)$ for the simplified Heisenberg model, $m = \pm\mu_0(J + 1/2)$ for the original Heisenberg model, where J denotes the intrinsic spin of one-particle states. For this purpose, the requirement for the vacuum is relaxed in the following way: Instead of the existence of the invariant vacuum, it is assumed that the vacuum corresponds to an irreducible unitary representation of Poincaré group with $p_\mu = 0$. That is, the existence of the infinitely degenerate vacuum is allowed. (auth)

13839 STANDARD INVARIANCE AND GENERALIZED YANG-MILLS FIELDS IN SELF-INTERACTION. Tugulea, M. N. (Univ. of Bucharest); Lyakhovski, V. D. Stud. Cercet. Fiz., 19: 823-57(1967). (In Rumanian).

Vector fields became very important as a result of recent studies on weak interactions and broken symmetries. In a similar manner, the standard invariance theories represent an intermediate stage for quantizing the gravitational field. The first example of the invariance theory for standard transformations is found in electrodynamics, superimposing the Abelian transformation group in accordance with the requirements of the law of the conservation of the charge with respect to the compensating electromagnetic field. The problem was examined by studying self-interaction cases based on the theory of the generalized Yang-Mills vector fields, and the standard invariance of the S-matrix. As the vector mesons which may be observed as resonances cannot serve as the basis for a renormalizable theory, the problem of zero-mass charged mesons was considered as a system of fundamental fields. In the absence of a better system, the otherwise discredited Lagrangian formalism was used. (TTT)

13840 ALGEBRAIC METHODS IN QUANTUM FIELD THEORY. Guenin, Marcel (Univ., Geneva). pp 187-253 of Lectures in Theoretical Physics. Vol. IX A. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

The study of two of the most important classes of algebras, namely, the C* algebras and the Von Neumann algebras, is presented. Also some of their applications to quantum field theory are examined. (J.F.P.)

13841 FIELD THEORY OF COMPOSITE PARTICLES AND BOOTSTRAPS. Broido, M. M. (Univ. of Kent, Eng.). pp 319-52 of Lectures in Theoretical Physics. Vol. IX A. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

An account of composite particles in field theory, this is specialized to the bootstrap equation, and the result is discussed in detail. This is a specialization in the sense that in field theory a bootstrap appears to be more or less just a system of particles, each of which is a composite of itself and the others. Elementary and composite particles, composite particles from elementary ones, bootstraps in field theory, N/D bootstraps, two-particle unitarity without N/D, vertex-function bootstrap, cutoffs and subtractions in bootstrap theory, setting up field theory bootstraps, and structure of field theory bootstraps are covered. (J.F.P.)

13842 FIXED POINT METHODS IN QUANTUM FIELD THEORY. Taylor, John G. (Rutgers Univ., New Brunswick, N. J.). pp 353-400 of Lectures in Theoretical Physics. Vol. IX A. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

The existence problem for local field equations and related equations is discussed. By local field equations is implied those equations which are derived from a local Lagrangian and quantised by canonical methods. In particular, an attempt is made to put local field equations in a form which does not involve the infinities and then to discuss the existence of solutions to these equations. The topics considered are the field equations in renormalized form and the relation of renormalization to the problem of products of distribution, the renormalized field equations as fixed-point equations, a survey of known fixed-point methods, application of these methods to the field equations, generalized Wick rotations, and Euclidean space–time theories. (J.F.P.)

13843 EQUATIONS CONTAINING HIGHER DERIVATIVES FOR THE ELECTROMAGNETIC FIELD. Romanova, T. S.; Fedorov, F. I. (Inst. of Physics, Minsk). pp 67-70 of Letnyaya Shkola po Problemam Teorii Elementarnykh Chastits, Kaariku, USSR, Avgust 1965. Tom IV. Palgi, L.; Yiglane, Kh. (eds.). Tartu, Instituut Fiziki Astronomii Estonskoi SSR, 1966. (In Russian).

In view of the difficulties of classical electrodynamics due to the infinite energy of the particular field of an electron, an attempt is made to modify the Maxwell equations by introducing higher derivatives in such a manner that the mathematical structure of the Green functions would be equivalent to the mathematical structure of the Green functions in the nonlinear theory of elementary particles of Heisenberg. It thus becomes possible to consider in detail the mathematical structure and physical interpretation of using an indefinite metric in Hilbert space proposed by Heisenberg. The simplest equations satisfying these requirements are sixth-order equations. The original Green function of these equations is written, and expressions are derived for the field potential and the field energy by following Heisenberg. The equations can be interpreted in a physical sense. (TTT)

13844 ANALYTIC FUNCTIONALS IN QUANTUM FIELD THEORY. Gorge, V.; Rohrlich, F. (Syracuse Univ., N. Y.). J. Math. Phys. (N. Y.), 8: 1748-56(Sept. 1967).

A class of Lorentz invariant generalized functions can be defined as analytic functionals, i.e., as continuous linear functionals which are contour integrals over a suitable space of test functions. These generalized functions include in particular the invariant functions of quantum field theory, but also include "propagators with higher order poles." The analysis shows exactly which of these are well defined, especially in the important special case of zero mass. Various applications to quantum field theory are indicated. (auth)

13845 GAUGE FIELD OF A POINT CHARGE. Loos, Hendricus G. (Douglas Advanced Research Labs., Huntington Beach, Calif. Univ. of California, Riverside). J. Math. Phys. (N. Y.), 8: 1870-7(Sept. 1967).

The problem and treatment of integration ambiguities in the conventionally defined Yang–Mills charges is demonstrated explicitly, using a non-Abelian solution of the Yang–Mills equations for a point charge. The internal holonomy group $\mathfrak{K}$ for this solution is noncompact and nonsemisimple, and the solution is not expected to have a direct physical meaning. However, it provides a convenient example showing important and quite unexpected features of gage theories of the Yang–Mills type, before quantization. It is found that the number of unambiguously definable and comparable charges is less than the dimension of $\mathfrak{K}$ and less than the rank of $\mathfrak{K}$ as well. If a gage group G is present in the conventional manner, i.e., $\mathfrak{K} \subseteq G$, this number of charges is less than the rank of the gage group. Other interesting features of the solution found are: discreteness of certain components of the gage field, as a result of regularity conditions together with the condition that the Yang–Mills charge density vanishes outside a sphere of finite radius, and a harmonic oscillation of the other gage components, while the observable charges are steady. Higher-order charges are all found to be zero. No action principle is used and no a priori particle fields are introduced. Use is made of the differential-geometric properties of gage fields. (auth)

13846 THE BETHE–SALPETER EQUATION AND GOLDSTONE BOSONS IN QUANTUM ELECTRODYNAMICS. Willey, R. (Univ. of Pittsburgh). pp 255-60 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

The implications of the Goldstone theorem for QED with zero bare mass for the electron are presented. The discussion is placed in a context of a nonperturbative approach to the problem of the divergences in QED. The observable consequences of the Goldstone theorem are discussed in the Nambu, Jona–Lasino model and then in QED with $m_0 = 0$. (J.F.P.)

13847 SCHWINGER TERMS, FIELD DEPENDENCE, AND COVARIANCE IN GENERAL FIELD THEORIES. Boulware, David G. (Univ. of Washington, Seattle). pp 261-71 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

The proof that the different components of a conserved current cannot commute is repeated. A vector field which may or may not be conserved, the massive vector field, and the covariance of time-ordered products are considered. The propagator found is covariant and conserved. Also the dispersion relation is more convergent than the original time-ordered product. (J.F.P.)

13848 CONDITIONAL DYNAMIC EQUIVALENCE OF FREE YANG–MILLS FIELDS AND FREE GRAVITATIONAL FIELDS. Loos, H. G. (Douglas Advanced Research Labs., Huntington Beach, Calif. Univ. of California, Riverside); Treat, R. P. Phys. Lett., 26A: 91-2(Dec. 18, 1967).

It is found that free Yang–Mills fields operating either on Dirac spin space or on the Lie algebra space of local homogeneous Lorentz transformations are dynamically equivalent to free Einstein gravitational fields, if the mapping between Riemannian event space and the Yang–Mills potentials is one to one up to uniform scale transformations. (auth)

13849 UTIYAMA IDENTITIES IN QUANTUM ELECTRODYNAMICS. Sniatycki, J. (Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 627-9(1967).

Identities which are satisfied by the generating functional of Green functions of quantum electrodynamics in Riemannian space-time and follow from invariance of the theory under coordinate transformations and local Lorentz transformations of local bases are derived. From these identities those for arbitrary Green functions may be obtained by functional differentiation with respect to external sources. The method used is essentially the same as that adopted by Bialynicki–Birula in treating gauge invariance of quantum electrodynamics. (J.F.P.)

13850 THE HAAG'S THEOREM FOR A GENERAL WIGHTMAN FIELD. Garczynski, W. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 647-53(1967).

The Haag theorem is proven for a general, neutral, scalar Wightman field which is free of a previous assumption that A(x) has nonvanishing matrix elements between the vacuum and the one-particle subspace. It is proven that the isometric connection between the intermediate subspace and the asymptotic one is possible only if the interaction is absent. This effect is a general one and holds in any scattering theory based on the Wightman-like system of axioms. It forms a strong criterion for a free character field, satisfying the Wightman axioms. (J.F.P.)

13851 ANOTHER PROOF OF HAAG'S THEOREM IN THE JOST MODEL. Garczynski, W. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 655-8(1967).

The Jost model of the Wightman field is considered, and the Haag theorem is proven in a simpler way using the Jost and Schroer result that was previously done. (J.F.P.)

13852 CRITERION FOR THE FREE CHARACTER OF FIELD. Garczynski, W. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 659-61(1967).

The necessary and sufficient criterion for the free character of the Wightman field of a special type is given. This field is called

the interpolating field and has an important part in scattering theory within the axiomatic approach to quantum field theory. The result presented may also be useful in the discussion of Haag phenomena in scattering theory. (J.F.P.)

13853 QUANTUM THEORY OF SCALAR FIELD WITH NONSTATIC SOURCE. Shirokov, M. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1277-86(Dec. 1967). (In Russian).

The model of the scalar field with a nonstatic source is considered. It is shown that the physical vacuum and the real meson in this theory are not described in terms of the in and out states. The state vector of the physical vacuum and the creation and annihilation operators for the real meson are defined and the Fock amplitudes are introduced and are defined by means of them. The reformulation of the theory in terms of these amplitudes results in the equation of motion that differs essentially from the original Schroedinger equation. (auth)

Gravitation and General Relativity

13854 REMARKS ON THE PRESENT STATE OF GENERAL RELATIVITY. Kichenassamy, S. (Institut Henri Poincare, Paris). pp 107-37 of Symposia on Theoretical Physics. Vol. 5. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

A brief sketch is given of the paths of research and formidable difficulties encountered in the development of relativity theory. Attention is given to the problems of gravitational collapse and quantization of gravitation. The foundations of the theory of special and general relativity theory are discussed in detail. (L.B.S.)

13855 FOUR-DIMENSIONAL UNITARY RELATIVISTIC MODEL OF QUANTUM FIELD THEORY WITHOUT DIVERGENCES. Volkov, M. K. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1100-10(Nov. 1967). (In Russian).

The Green functions and the scattering amplitude of scalar particles are investigated in the four-dimensional relativistic Bialynicki-Birula's model. It is shown that the ultra-violet divergences are absent and the condition of the unitarity of S-matrix is fulfilled in the second order of the perturbation theory with an expansion in Δm (nucleon mass difference in two possible states). (auth)

13856 COVARIANT METHOD OF INFINITESIMAL TRANSLATIONS. Folomeshkin, V. N. (Moscow State Univ.). Yadern. Fiz., 6: 1080-3(Nov. 1967). (In Russian).

A covariant method of the infinitesimal translations in the Riemann space is formulated. An expression is obtained for the tensor that can be interpreted as a covariant generalization of the canonical energy-momentum tensor for the system consisting of the matter and the gravitational field. (auth)

13857 MACROSCOPIC GRAVITATIONAL FIELD IN THE STANDARD QUANTUM FIELD THEORY. Treder, Hans-Juergen (Institut fuer Relativistische und Extragalaktische Forschung, Potsdam, Ger.). Ann. Phys. (Leipzig), (7), 20: 194-206(1967). (In German).

A theory of the gravitation field is proposed in connection with a new spinorial formulation of Einstein's equivalence principle and Heisenberg's unified quantum theory of fields. In the gravitation theory the gravitational field is given by the coefficients $h_i^{\wedge}(x^j)$ of the matrix of the anholonomic non-Lorentzian transformations from the Lorentzian metric η_{AB} to the physical metric $g_{ik}(x^l)$ of the Riemannian space-time V_4. The field equations and the commutation rules for the $h_i^{\wedge}$ are working in the Lorentzian space. The metric of the Riemannian V_4 is given by the average $g_{ik} = \langle h_i^{\wedge}, h_k^{\beta} \rangle \eta_{A\beta}$. For all matter fields (and for Heisenberg's "Urfeld") the field equations are equations in this Riemannian V_4. The interaction between the gravitational field $h_i^{\wedge}$ and the matter-tensor is given by a potential-like coupling-term. It is proven that this theory of gravitation gives for macroscopic matter the linear approximation equations similar to those of general relativity and that a perihelmotion $\delta\varphi \approx {}^{1}/_{6}\,\delta\varphi_{\text{Einstein}}$ results in the second approximation. But, essential differences with general relativity are found for the theory of gravitational radiation and for the theory of interaction of matter with strong gravitation fields. (auth)

13858 TWO CONSEQUENCES OF GRAVITATION THEORY IN EUCLIDEAN SPACE. Korkina, M. P. (Dnepropetrovskii Univ., USSR). pp 52-8 of Letnyaya Shkola po Problemam Teorii Elementarnykh Chastits, Kaariku, USSR, Avgust 1965. Tom IV. Palgi, L.; Yiglane, Kh. (eds.). Tartu, Instituut Fiziki Astronomii Estonskoi SSR, 1966. (In Russian).

A nonlinear theory of gravitation in plane space can be constructed by introducing the following interaction term into the gravitational field Lagrangian: $-\alpha/2(h_{\mu i}\tau_{\mu i})$. Here $\alpha = \gamma^{0.5}/c^2$ is the gravitational constant; γ is Newton's constant; $h_{\mu\nu}$ is the gravitational field potential, and $\tau_{\mu\nu}$ is the symmetrical tensor of the energy-momentum of the gravitational field with the spin addition taken into account. In order that the results of the theory can be compared with the results of the general theory of relativity, an expression obtained from the Lagrangian of the general theory of relativity is taken as the initial linear Lagrangian. Gupta's notation is used for ease of comparison. It is found first that the nonlinear theory of gravitation in Euclidean space on considering the interaction of the gravitational field with other fields gives the same results as the general theory of relativity, in any case up to a second approximation in α. For practical purposes the method significantly simplifies the calculations. Secondly, in Euclidean space an exact nonlinear equation of the gravitational field can be obtained whose solution coincides with Schwarzshild's solution of the general theory of relativity. (TTT)

13859 ASTRONOMICAL TESTS OF GENERAL RELATIVITY. Detre, L. (Konkoly Observatory, Budapest). Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Geol., 7: 99-108(1963).

The present state of observational verification of the three classical effects–perihelion advance of planets, gravitational shift of spectral lines, and light deflection in a gravitational field–is outlined. (auth)

13860 EQUATIONS OF MOTION AND RADIATION REACTION. Kuehnel, A. (Karl Marx Univ., Leipzig). Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Geol., 7: 43-6 (1963).

The Einsteinian field equations and the equations of motion are expanded into powers of the gravitational coupling constant. Starting from the equations for continuously distributed matter, one arrives at the equations of motion for a system of point-like particles. First and second approximations are considered. Finally, the equations of motion for point-like particles are obtained free from infinities and containing the radiation reaction terms. (auth)

Scattering Theory

Refer also to abstracts 13800, 13839, and 13852.

13861 (COO-1573-31) SOME CONSEQUENCES OF THE PROPERTIES OF THE INTERNAL SYMMETRY CROSSING MATRICES. Kottler, Herbert (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). Sept. 1967. Contract AT(11-1)-1573. 178p. Dep. CFSTI.

The general properties of the internal symmetry crossing matrices for an arbitrary compact internal symmetry group are investigated. Then the consequences of these properties are considered in three problems where the crossing matrices play an important role. In the first, a statistical model for high energy, large angle two-particle scattering with which one can calculate average branching ratios is formulated. The crossing matrices enter into this model through the requirement that the average cross section be independent of the channel through which one views the reaction. Next, a u-channel dominance theorem is proven which, in essence, states that the only single internal symmetry reduced amplitude that can dominate the u-channel contribution to an s-channel process is that reduced amplitude which corresponds to the maximum weight representation in the u-channel. This theorem is the u-channel analogue of the t-channel dominance theorem of Amati, et al. Finally, the role which the elements of the crossing matrices play in a simple self bootstrap model for a scalar particle is studied. (auth)

13862 (LPTHE-TH-219) DERIVATION OF NONRELATIVISTIC SUM RULES FROM CAUSALITY. Chadan, K.; Montes, A. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Oct. 1967. 51p. Dep.

Nonrelativistic sum rules obtained previously in the framework of elastic scattering by a local potential are shown to follow from the Causality Principle of Wigner and Van Kampen. It is shown in fact that under the mild and plausible assumption that the phase shift, in the limit of high energy, goes to a multiple of π such as to satisfy conditions (6a, b) and the Levinson theorem, the causality condition is equivalent to assuming a local potential inside the interaction region. In other words, it is shown that any interaction which is causal and for which (6a, b) and the Levinson theorem hold is equivalent to a local potential of radius R. (auth)

13863 (LPTHE-TH-228) ON SOME SINGULARITIES OF THE REGGE POLE MODEL AT MASS ZERO. Omnes, R. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Nov. 1967. 9p. Dep.

The behavior of a Regge pole expansion when the mass of a physical particle tends to zero is considered. If this variation of

the mass is obtained by letting some parameter λ vary, it is found that the analytic form of the residues must change discontinuously when the mass passes through zero. Such an effect is called a transition, by analogy with statistical mechanics. Some consequences are given, concerning the reliability of perturbation expansion, zero mass pions and their Toller classification, the Pomeranchuk singularity. (auth)

13864 REGGE POLES AND EXPERIMENTAL DATA. Ter-Martirosyan, K. A. pp 479-523 of Voprosy Fiziki Elementarnykh Chastits. Alikhanyan, A. I. (ed.). Erevan, Izdatel'stvo Akademii Nauk Armyanskoi SSR, 1966. (In Russian).

Applications of the theory of Regge poles and the subject of agreement between this theory and experimental data are reviewed. The conclusion is reached that the difficulties which arose in connection with Regge poles are not associated with experimental data, but are due to the theory itself. It is proposed, in accordance with the theoretical relations derived by S. Mandelstam (Nuovo Cim., 30: 1127, 1143, 11313(?)(1963)) that the poles in the j-plane be regarded as branched, with the branchings making significant contributions to the asymptotics of the amplitude. Experimental data should be compared with the simplest theoretical model comprising several Regge poles (hypotheses based on one Regge pole conflicted with experimental results) and also with a more general model based on the assumption that the characteristics furthest to the right in the j-plane do not constitute simple poles, but have a more complex nature. The variant of the theory that agrees best with experimental data can then be selected. (JPRS)

13865 CRITERION OF WEAK PERTURBING SYSTEMS BASED ON ELASTIC SCATTERING MEASUREMENTS. Ivanov, V. V.; Fedorovich, G. V. (Inst. of Optico-Physical Measurements, Moscow). Zh. Eksp. Teor. Fiz., 53: 2012-24(Dec. 1967). (In Russian).

A criterion is proposed which can be used for identifying systems which weakly perturb incident waves during scattering. It is based on a comparison of the elastic scattering differential cross sections measured for different impinging particle energies. The criterion is investigated for the case of scattering of neutrons on nuclei and for some cases of scattering of fundamental particles. It is demonstrated that nuclei exist which weakly perturb the neutron wave. The Orear formula for nucleon—nucleon scattering and some properties of the angular distribution of elastically scattered high energy particles are interpreted as being a consequence of weakness of perturbation of the incident wave. (auth)

13866 AMPLITUDE OF A NONRELATIVISTIC SQUARE DIAGRAM. Blokhintsev, L. D.; Truglik, E. (Inst. of Nuclear Physics, Moscow). Zh. Eksp. Teor. Fiz., 53: 2176-85(Dec. 1967). (In Russian).

The explicit form of the amplitudes of all types of nonrelativistic square diagrams with constant vertex functions is obtained. The analytic properties of the amplitudes are derived and branches of their proper singularities on the physical sheet are singled out. (auth)

13867 EXPANSION OF THE T MATRIX FOR RESONANCE COLLISIONS. Micha, David A. (Univ. of Wisconsin, Madison). J. Math. Phys. (N. Y.), 8: 1716-19(Sept. 1967).

The eigenfunctions of the kernel of the Lippmann–Schwinger collision equation, corresponding to outgoing waves in all channels, are used to obtain an expansion of the T matrix valid for multichannel collisions, including rearrangements. From this expansion, the transition amplitude in the general case of overlapping resonances is obtained and a characterization of bound states and resonance states is given. (auth)

13868 ENERGY-MOMENTUM CONSERVATION IMPLIES TRANSLATION INVARIANCE: SOME DIDACTIC REMARKS. Williams, David N. (CEN, Saclay, France). J. Math. Phys. (N. Y.), 8: 1807-16(Sept. 1967).

Two more-or-less familiar cases where energy-momentum conservation implies invariance under space–time translations from a rigorous point of view. First, if a closed linear operator on a Hilbert space has a domain that is invariant under spectral projections belonging to the four-momentum operators, and if it "conserves energy-momentum," it necessarily commutes with the appropriate representation of the translations. (Bounded operators, such as the S matrix, are a special case.) At least for separable spaces, the domain restriction characterizes the closed operators for which the theorem is true. Second, if a bounded bilinear form between momentum states of m and n particles in a Fock space (or more generally, a bounded multilinear form) conserves energy–momentum, the corresponding tempered distribution has a conservation delta function at points where the mass shell is a C_∞ manifold; but no derivatives of delta functions can occur. In this connection, one is led to a result that seems to be new; the cluster parameters ("connected amplitudes") of a family of bounded bilinear forms, labeled by (m, n), are also bounded bilinear forms. The two systems, of course, mutually conserve energy momentum. (auth)

13869 HIGH-ENERGY PHASE SHIFTS PRODUCED BY REPULSIVE SINGULAR POTENTIALS. Paliov, A.; Rosendorff, S. (Technion-Israel Inst. of Tech., Haifa). J. Math. Phys. (N. Y.), 8: 1829-37(Sept. 1967).

An expansion in inverse powers of the energy (usually fractional powers) of the WKB phase shifts δ_l produced by repulsive potentials, singular at the origin, was derived. In most cases this expansion is valid for angular momenta $l < l_{max}$, where l_{max} increases with energy. For large l a power series expansion in the "coupling constant" g is developed. The two regions of validity complement each other and sometimes even overlap. The potentials considered have an r^{-p}, $p \geq 1$, singularity and a k^m, $m < 2$, energy dependence. Define $q = p + m - 2$; then for $q > 0$, the case of strong interaction, one obtains $\delta_l \sim -(gk^q)^{1/p}$, when $k \to \infty$. The constant of proportionality is independent of l. However, the next term in the expansion depends on l. For $q = 0$, the case of intermediate interaction, δ_l becomes independent of energy when $k \to \infty$, but it depends in a complicated way on both g and l. Finally, for $q < 0$, the case of weak interaction, $\delta_l \sim -gk\ (l + \frac{1}{2})^{1-p}$, $p > 1$. (auth)

13870 ALGEBRAIC CALCULATION OF NONRELATIVISTIC COULOMB PHASE SHIFTS. Zwanziger, Daniel (New York Univ., New York). J. Math. Phys. (N. Y.), 8: 1858-60(Sept. 1967).

It is observed that the in and out states of a particle of energy $k^2/2m$, entering or leaving a Coulomb field along the +z direction, are eigenstates of L_3 with eigenvalue 0, and of A_3, the third component of the Runge–Lenz vector, with eigenvalues $\pm\alpha + ik/m$, respectively. From this characterization and the commutation relations of the symmetry group, the phase shifts are easily obtained algebraically. (auth)

13871 THREE-PARTICLE STATES AND GREEN'S FUNCTION. Pasquier, Jeanne-Yvonne (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). J. Math. Phys. (N. Y.), 8: 1878-85(Sept. 1967).

The six-dimensional spherical harmonics are specified in connection with SO_6 and particular subgroups isomorphic to SO_5 and SO_3; three-particle states are then labeled by the grand-angular momentum n, the usual angular momentum j, its projection on a fixed axis m, an integer μ related to SO_3, and a degeneracy number ω. Also, the plane-wave and free Green's function expansions are derived in terms of these spherical harmonics. (auth)

13872 THRESHOLD BEHAVIOR OF PARTIAL-WAVE AMPLITUDES. Dilley, J. (Ohio Univ., Athens). pp 69-76 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

A method for obtaining the correct threshold behavior in partial wave scattering amplitudes is considered. For this purpose the partial wave dispersion relations are examined. The discussion involves the modification of the input itself. (J.F.P.)

13873 IMPROVED METHOD OF ABSORPTIVE CORRECTIONS IN THE PERIPHERAL MODEL. Warnock, Robert L. (Illinois Inst. of Tech., Chicago. Argonne National Lab., Ill.). pp 147-54 of Lectures in Theoretical Physics. Vol. IX B. Brittin, Wesley E.; Barut, Asim O. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

A generalized matrix N/D method which can be used to overcome some previous objections to the use of the peripheral model for absorptive corrections is described. It is concluded that the matrix N/D equations with arbitrary inelasticity provide a favorable general framework for discussions of absorption. (J.F.P.)

Particle Accelerators

Refer also to abstracts 12642, 12690, 13381, 13620, 13630, 13905, 13927, 13955, and 14025.

13874 (CERN-67-26(Vol.1), pp 49-71) THE DETECTION OF π^0 MESONS, NEUTRONS, AND NEUTRINOS AT THE 300-GeV ACCELERATOR. Leutz, H. (European Organization for Nuclear Research, Geneva (Switzerland)).

With respect to the detection of mesons (π^0), neutrons, and neutrinos the construction of a cylindrical-shaped cryogenic bubble chamber with about 15 m diameter, a vertical symmetry axis, and a useful height of about 4 m at the 300 GeV accelerator is proposed. Depending on the experiments envisaged this chamber could be filled with hydrogen or with neon–hydrogen mixtures. Beam

targets made of mylar, filled with hydrogen or deuterium and having appropriate shapes for neutrino- or strong interaction physics, should be mounted inside this chamber. (auth)

13875 (RHEL/R-147) FAST SHUTTER MAGNETS FOR SEPARATED PARTICLE BEAMS. Edwards, V. W.; Elliott, R. T.; Mathews, W. A. (Rutherford High Energy Lab., Chilton (England)). June 1967. 34p. Dep. CFSTI. UK 5s. 6d.

Separated particle beams supply fast bursts of particles at various momenta for bubble chamber experiments. Fast shutter magnets are intended to deflect the beam from its normal path after the required number of particles has entered the chamber, thus preventing large statistical fluctuations in the number of tracks appearing on the film. Also, since the magnet may be set to deflect the remainder of fast spill away from the chamber at a preset time after the beginning of spill, greater control of track density uniformity on the film is made possible by limiting the variation in bubble growth time. The shutter magnets designed and built for separated beams at Nimrod, the 7 GeV proton synchrotron at the Rutherford Laboratory, are described. (auth)

13876 (RPI-328-100, pp 188-93) INSTRUMENTATION DEVELOPMENT. (Rensselaer Polytechnic Inst., Troy, N. Y.).

The status of the communications link between Rensselaer Polytechnic Institute and the CDC-6600 at New York University is outlined. Improvement of the Rensselaer linac by addition of a new accelerator section and the description of a new multiple drift tube installation for multiple-flight-path experiments are briefly discussed. (W.H.K.)

13877 (SLAC-PUB-369) EXPERIMENTAL PROGRAM AT THE STANFORD LINEAR ACCELERATOR CENTER. Diebold, R. (Stanford Linear Accelerator Center, Calif.). Jan. 1968. Contract AT(04-3)-515. 49p. Dep. CFSTI.

The present status of the experimental high-energy physics program at SLAC is discussed. The experimental arrangements are described, together with those preliminary results already obtained. (auth)

13878 (BNL-tr-180) TELEMANIPULATION IN A BIG ACCELERATOR. Richter, Wolfgang; Ellefsplass, Melvin; Horne, Roger Alan. Translated for Brookhaven National Lab., Upton, N. Y., from Ind. At., 11: No. 1/2, 77-85(1967). 18p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The possibilities of maintenance and repairs to equipment in hot (radioactive) zones in the ring of the CERN proton synchrotron by remote handling are described. (B.G.D.)

13879 A SMALL ACCELERATOR FOR LIGHT IONS WITH UHV IN THE $T_{75}T$ CHAMBER. Behrisch, R. (Inst. fuer Plasmaphysik GmbH, Munich). Vakuum-Tech., 16: 250-6(Dec. 1967). (In German).

A small accelerator for light ions was constructed which produces a constant ion beam of 0.5 to 1.5 mA H^+ focused to a diameter of about 5 mm. The energy is adjustable between 50 and 150 keV. The ions are extracted from a RF ion source, accelerated in two stages to the full energy and mass separated by a magnetic sector field. The vacuum system comprises three pumping units. In the target chamber, which can be baked out up to 450°C, a residual gas pressure of $<10^{-9}$ torr can be attained. The operating pressure depends on the intensity of the ion beam and is in the range 10^{-7} to 10^{-8} torr Hg. (auth)

13880 PARTICLE ACCELERATORS FROM THE CSF (COMPAGNIE GENERALE DE TELEGRAPHIE SANS FIL). Guilbaud, Georges (Domaine de Corbeville, Orsay, France). Atompraxis, 13: 563-8(1967). (In German).

The development of atomic and nuclear physics research and of the medical and industrial applications of radiation has lead to the construction of numerous and varied models of particle accelerators. A survey of the products of the Compagnie Générale de Télégraphie Sans Fil, which cover electron linear accelerators from a few MeV to 2.5 GeV, isochronous cyclotrons for protons, deuterons and heavy ions in the 50 to 120 MeV range, linear accelerators for protons and heavy ions, and ion sources. (auth)

13881 ASYMMETRIC FEEDING OF A MAGNETIC QUADRUPOLE LENS. Keck, Ch.; Liebig, W.; Pose, H. (Institut fuer Experimentelle Kernphysik, Pirna-Copitz, Ger.). Kernenergie, 10: 273-6(Sept. 1967). (In German).

Based on an earlier paper describing a method for determination of the operation conditions of an asymmetrically fed quadrupole system, the shift of the field axis is determined from the measured image displacement. The conditions with respect to the accelerator of our Institute are discussed, calculated, and compared with experimental results. (auth)

13882 INDUSTRIAL USE OF LARGE RADIATION SOURCES. III. ACCELERATOR IRRADIATION PLANTS. Meyer-Jungnick, W. (Leybold-Heraeus GmbH, Cologne); Trageser, D. A.; Wiesner, L. Atomwirt., Atomtech., 12: 535-9(Nov. 1967). (In German).

A description is given first of the principles of the main types of accelerator equipment, e.g., Van de Graaff electrostatic generators, Greinacher and Cockcroft-Walton cascade generators, insulating core transformers, and electron linear accelerators. The accelerators described may be assigned to three ranges of energy which are technically determined by the application conditions. The range from 300 to 750 keV covers those uses which only need small penetration depths, that from 1 to 4 MeV is for similar uses but where the layer thicknesses of the products to be dealt with and penetrated exceed a few millimeters. The energy range of 5 to 12 MeV and above is of interest for certain tasks in the pasteurization of foodstuffs. In describing industrial operating experience with accelerators the types and the applications of the installation are considered. The capital and operating costs are listed for various irradiation capacities in different types of installation. A review of the development tendencies shows that, in the foreseeable future, accelerators will be technically feasible which will deliver 100 kW of power at, e.g., 500 keV. At the same time the power output of machines in the energy range around 2.5 MeV will be raised to over 50 kW. It is apparent that technical development is already far in advance of process requirements. (auth)

13883 ASYMPTOTIC THEORY OF BEAM BREAK-UP IN LINEAR ACCELERATORS. Panofsky, W. K. H.; Bander, M. (Stanford Univ., Calif.). Rev. Sci. Instrum., 39: 206-12(Feb. 1968). (SLAC-PUB-342).

The phenomenon of radial beam break-up observed in terms of long, multi-section electron linear accelerators was analyzed using a multicavity model. In this model the source of regeneration due to backward wave amplification is ignored. The dominant phenomenon involves buildup of radial modes in each cavity as coupled by the electron beam. The resulting differential equations are integrated by the method of steepest descent and by a numerical iteration method. Scaling laws in terms of the pulse length, beam intensity, energy gradient, and length of the structure are derived. (auth)

13884 SQUARE AND SINE WAVE MODULATION OF THE BEAM FROM A 3 MV VAN DE GRAAFF ACCELERATOR. Fraser, H. J.; Ritchie, A. I. M.; Whittlestone, S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Rev. Sci. Instrum., 39: 240-4 (Feb. 1968).

Methods of producing square and sine wave beam modulation of a 3 MV Van de Graaff accelerator are described. Square pulses are produced at frequencies from 100 kc to zero with up to a 100% duty cycle and a minimum pulse length of 8 μsec. The ratio of the off-current level to the on-current level is less than 5×10^{-4} and can be further reduced by a post-acceleration deflection system to less than 10^{-6}. The unit, which is triggered from a command pulse external to the machine, is in the top terminal of the Van de Graaff and has shown itself to be highly reliable over some 1000 h of machine operation. The sine wave modulation unit described here operates in the range 80-1000 cps with a modulation depth of up to 90% and higher harmonic contamination of less than 1%. (auth)

13885 UNGRIDDED ELECTROSTATIC MIRROR. Larson, J. D.; Benjamin, J. A. (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instrum., 39: 272-3(Feb. 1968). (BNL-11698).

One of two model MP Tandem Van de Graaff accelerators being installed at Brookhaven National Laboratory will be modified to serve as a negative ion injector for the second accelerator by the installation of a duoplasmatron ion source in its high voltage terminal. To retain normal tandem acceleration capability, this ion source will be located off-axis with provision for bending ions from the source onto the acceleration axis. An ungridded electrostatic mirror was tested for this application. (auth)

13886 OPERATING CONDITIONS OF A QUADRUPOLE SYSTEM. Keck, Ch.; Liebich, W.; Pose, H. Kernenergie, 10: 247-50(Aug. 1967). (In German).

The ion optical properties of a quadrupole system are described. A graphical method is given and enables in a simple manner to obtain relations between object and image distance, the lateral magnification and image displacement, due to asymmetrical feeding. (auth)

13887 VAN DE GRAAFF TYPE POSITIVE-ION ACCELERATOR OF ORC. Furuta, Junichiro; Hiraoka, Eiichi; Fujishiro, Masatoshi; Okamoto, Shinichi; Kanazawa, Tamotsu; Ohnishi,

Tokuhiro; Tsujii, Yukio; Azuma, Toshio. Annu. Rep. Radiat. Center Osaka Prefect., 7: 68-71(1966).

The outline of the Van de Graaff type positive-ion accelerator for neutron production and its operation characteristics are discussed. The characteristic features of the accelerator are as follows: the accelerating voltage and the beam current are 0.3 to 1.2 MV and 10 to 120 μA, respectively, and their stabilities are within few percent, the accelerator is horizontally mounted, the acceleration voltage and the beam current can be preset, H_2 gas can be exchanged to D_2 by remote switching, the beam diameter on the target can be changed at any value, and the accelerator is easy to operate and has good stability. (auth)

13888 EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH IS GOING TO MULTIPLY BY TEN ITS MEANS OF ACTION. Anthoine, Roger (CERN, Paris). Rev. Fr. Elec., 40: No. 217, 24-39(1967). (In French).

The CERN plans for expansion and construction of an intersecting storage ring and a 300 GeV accelerator are briefly discussed. The studies that can be made with these instruments are indicated. (J.S.R.)

13889 FREQUENCY-TUNING DEVICE FOR A LINEAR ION ACCELERATOR. Fujita, Hyota (to Mitsubishi Electric Corp. Mitsubishi Atomic Power Industries Inc.). Japanese Patent 1966-13079. July 22, 1966. Filed Apr. 28, 1965.

A frequency-tuning device is described which consists of a handle-rod penetrating through the wall of a cavity body and extending into the cavity body; a frequency-tuning member of a highly conductive metal, attached at the inner end of the handle-rod; and the bellows of a highly conductive material, within the cavity body, the inner end of which adheres to the tuning member and the outer end adheres to the inside surface of the cavity body. When the handle-rod moves inward or outward, the bellows extend or contract; and the vacuum in the cavity body is maintained by means of the bellows. (NSA of Japan)

13890 PARALLEL-ELECTRODE TYPE CHARGED PARTICLE ACCELERATOR. Imamura, Gen (to Mitsubishi Atomic Power Industries, Inc.). Japanese Patent 1966-13078. July 22, 1966. Filed Apr. 28, 1965.

The parallel-electrode type charged particle accelerator proposed has the following advantages: complete prevention of electric discharges; simplicity in the installation of large resistors; simple over-all construction; increase in the strength of the accelerating tube; maintaining of sufficiently high vacuum; and ease in the construction of an accelerating tube. It consists of a large number of disc electrodes, arranged axially at regular intervals; the short insulating tubes, placed between the disc electrodes; and the mold of a highly insulating material which surrounds the accelerating tube proper with the protruding part of the disc electrodes being completely embedded in the mold. (NSA of Japan)

13891 THE PROPOSED 300-GeV ACCELERATOR. Command 3503. London, Her Majesty's Stationery Office, [1968]. 84p. 7s. 9d.

Paper presented to Parliament by the Secretary of State for Education and Science by Command of Her Majesty, January 1968, incorporating the advice of the Council for Scientific Policy and that of the Science Research Council concerning UK participation in the proposed 300-GeV proton synchrotron project at CERN (European Organisation for Nuclear Research). (UK)

13892 SPATIALLY ALTERNATING GRADIENT VOLTAGE SYSTEM FOR A VAN DE GRAAFF ACCELERATOR. Kane, John V. (to Bell Telephone Labs., Inc.). U. S. Patent 3,361,980. Oct. 19, 1965.

A Van de Graaff accelerator capable of producing higher energy particles for a given length and configuration by the superimposition of a spatially alternating component of the overall electrostatic voltage gradient is described. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 13530, 13545, 13604, 13865, 13887, 13926, 14026, 14296, and 14306.

13893 (AE-309) MEASUREMENT OF THE DECAY OF THERMAL NEUTRONS IN WATER POISONED WITH THE NON-1/v NEUTRON ABSORBER CADMIUM. Larsson, L. G.; Moeller, E. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Jan. 1968. 19p. Dep.

Measurements were made of the decay constant of thermal neutrons in water poisoned with the non-1/v absorber cadmium. An experimental method was used with proper spatial integration of the neutron flux. This made it possible to accumulate data, representative of the infinite medium, without waiting for the establishment of a fundamental mode distribution. The change in effective cross section with concentration of the dissolved cadmium, $d\sigma_{eff}/dN^{-1}$, was determined for infinite medium at 20°C. Two- and three parameter fits of the decay constant yield $-0.32 \pm 0.09 \times 10^{-17}$ barn cm^3 and $-0.47 \pm 0.10 \cdot 10^{-17}$ barn cm^3, respectively. (auth) (Sweden)

13894 (AERE-M-1690) DESIGN OF A LIQUID HYDROGEN COLD NEUTRON SOURCE FOR THE 6H HOLE IN DIDO. Merrett, D. J.; Pearce, D. G.; Webb, F. J. (Atomic Energy Research Establishment, Harwell (England)). Oct. 1966. 62p.

A summary is presented of the design work for a second cold neutron beam source for the reactor DIDO. The scope of cold neutron scattering experiments and the present knowledge of low-temperature moderators are described, and the scientific and technical aspects of a cold source in the 6H hole discussed. It is concluded that a liquid hydrogen source in the 6H hole could provide a cold neutron beam eight times as intense as the present 4H5 beam. The refrigeration required would be 1000 watts at 20°K, together with an additional 200 watts for the simultaneous operation of the 4H5 liquid hydrogen source. (auth) (UK)

13895 (AERE-R-5574) SCATTERING LAW $S(\alpha,\beta)$-VALUES FOR GRAPHITE AT 1300°K AND 1800°K. Page, D. I. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1967. 24p. Dep. CFSTI. UK 4s. 0d.

The differential scattering cross sections of graphite at 1300 and 1800°K were measured for neutrons of 0.101-eV and 0.054-eV (1800°K only) incident energy. The results are given as tables of scattering law $S(\alpha,\beta)$ values derived directly from the experimental data. The values cover ranges of energy and momentum transfers of 0 to 0.4 eV and 1 to 19 Å^{-1}, respectively. (auth) (UK)

13896 (AERE-R-5627) CRITICAL INELASTIC SCATTERING OF SLOW NEUTRONS FROM A BINARY LIQUID METAL MIXTURE (Bi-Zn). Egelstaff, P. A.; Wignall, G. D. (Atomic Energy Research Establishment, Harwell (England)). Oct. 1967. 17p. Dep. CFSTI. UK 3s. 0d.

An expression for the intensity of coherently scattered radiation from a binary mixture is derived in terms of scattering from the density and concentration fluctuations. It is shown that in the consolution region the scattered intensity is due predominantly to the concentration fluctuations. A preliminary measurement of critical opalescence in liquid metal systems (Bi-Zn) is described, using the inelastic scattering of slow neutrons. The spectra are clearly separable into a Q-dependent quasielastic region associated with scattering from the concentration fluctuations of the system, and an inelastic region associated with the interatomic modes of vibration of the system. For the former region, no departure from the theory of Ornstein and Zernicke (1918, 1928) was observed, leading to a value of $\eta \sim 0$ for the range of Q observed 0.05 to 0.9 Å^{-1}. At values of Q beyond 0.9 Å, the Ornstein-Zernicke theory does not describe the scattering. It is shown how the critical indices γ, ν, and δ, may be obtained from scattering data; and a future experimental program is outlined. (auth) (UK)

13897 (AWRE-O-92/64) OPTIMISATION OF NEUTRON CROSS SECTION DATA ADJUSTMENTS TO GIVE AGREEMENT WITH THE RESULTS OF INTEGRAL EXPERIMENTS. Pendlebury, E. D. (Atomic Weapons Research Establishment, Aldermaston (England)). Sept. 1964. 25p.

A method that permits the optimization of neutron cross-section data to be carried out to give agreement with the results of integral experiments is described. The method is mechanized for use on the IBM 7030. Some numerical examples are given to demonstrate the method. (D.C.W.)

13898 (EUR-3742) NUMERICAL APPROACH TO THE TIME-DEPENDENT DIFFUSION EQUATIONS. Daneri, A. Colonelli; Daneri, A.; Galligani, I. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center. Applicazioni e Ricerche Scientifiche, Milan (Italy)). 1968. 26p. Dep.

A numerical method for the solution of the time-dependent neutron diffusion equations, which is well adapted to describe accurately very fast transients, is discussed. The convergence of some iterative methods which determine the approximate solution of the neutron diffusion equations is proved. (auth)

13899 (GA-8003) GANDY: A COMPUTER PROGRAM FOR THE EVALUATION OF EFFECTIVE CROSS SECTIONS IN THE UNRESOLVED RESONANCE REGION. Cohen, S. C.; Koch, P. K. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). May 22, 1967. Contract AT(04-3)-167. 59p. Dep. CFSTI.

A computer program, GANDY, was written to evaluate temperature-dependent effective neutron capture, fission, and scattering cross sections in the unresolved resonance region. Utilizing the isolated resonance approximation, the code considers s-, p-, and d-wave neutron orbital angular momenta and includes the effect of interference scattering. Fissile cross sections are computed for chi-squared fission width statistical distributions with one, two, three, or four degrees of freedom. The program was written in the FORTRAN-IV language and was run on a UNIVAC-1108 computer. (auth)

13900 (IA-1144) MODERN FAST REACTOR CROSS SECTION SYSTEMS. Yiftah, S.; Segev, M.; Lemanska, M.; Caner, M. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). Nov. 1967. 16p. Dep.

Mainly three problems must be solved in the preparation of a group cross section set for fast reactor calculations. The first step is an evaluation of the basic nuclear data, based on experimental information, systematics, nuclear model calculations, and clarification of discrepancies. The second class of problems relates to the proper definition of group cross sections as stems from an accurate multigroup theory. The third problem concerns the weighting fluxes for the group-averaging of the data. Different group tables types stem from different structures in the flux. With the above consideration in mind, three modern group cross section sets were compared. These are the Russian 26-group set ABN, the Argonne 22-group set ANL, and the recently constructed Israeli 30-group set YSL. In the comparison, attention was paid to group structure, type of cross sections, and the representation and magnitude of self-shielding factors and temperature-dependence. Some typical fast reactor problems were run with the ABN and YSL sets; the results were compared. (auth)

13901 (IAE-1362) IZMERENIE SPADA NEITRONNOGO IMPUL'SA V MALYKH BLOKAKH BERILLIYA I OKISI BERILLIYA. (Measurement of the Decay of a Neutron Burst in Small Blocks of Beryllium and Beryllium Oxide). Zhezherun, I. F. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1967. 24p. (In Russian). Dep.

Experiments on the supplementary accurate measurement of the decay of neutron bursts in small blocks of Be and BeO with geometric parameters up to 0.1 cm^{-2}. The effect of the alteration of the experimental conditions (background level, different shields for the blocks, etc.) on the results was determined. The output of the neutron source and the detectors used made it possible to observe the decay of the neutron density on a range of four decades in time intervals from 0 to 1.5 to 2 msec. The decay constants were determined from measurements of the neutron density by the least squares method. Exponential decay was observed with significantly larger than λ_{lim}. (tr-auth)

13902 (IAE-1363) IZMERENIE DIFFUZIONNYKH PARAMETROV V GRAFITOVOI SREDE S KANALAMI IMPUL'SNYM METODOM. (Measurement of the Diffusion Parameters in a Graphite Medium with Channels by the Pulse Method). Zhezherun, I. F. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1967. 20p. (In Russian). Dep.

Experiments for the study of the diffusion of neutrons in graphite media having a square lattice of cylindrical channels of radius 0.8 cm and spacing of 2.0 cm and in solid graphite are described. The decay constant λ was measured in graphite blocks of different dimensions. The decay constant was calculated from the measurement of the decay of the neutron density with time. The analysis of

the dependence of λ on the geometric parameter B^2 for solid graphite and on the longitudinal $B^2_{||}$ and on the transverse $B^2_{\perp}$ parameters for graphite with channels gave the possibility of obtaining the diffusion coefficient and diffusion cooling for this decay and relations between them. The ratio of the coefficients $D_{||}/D_0$ and $D_{\perp}/D_0$ was compared with calculations by Behrens theory. (tr-auth)

13903 (IDO-17257) PDQ-40: AN IBM 7040-44 PROGRAM FOR THE SOLUTION OF THE STEADY STATE NEUTRON DIFFUSION EQUATIONS IN TWO DIMENSIONS. Wagner, R. J.; Poetschat, George R. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Nov. 1967. Contract AT(10-1)-205. 48p. Dep. CFSTI.

The program PDQ-40, an IBM 7040-44 computer program which obtains a numerical solution to the few group, time-independent, two-dimensional neutron diffusion equations, is described. The solution is obtained either over a rectangular surface in x-y coordinates or over a right cylinder in r-z coordinates. The number of lethargy groups is limited to four, and the total number of points of solution is limited to 20,000. Either a zero flux or zero derivative (mirror symmetry) condition can be applied along each exterior boundary of the problem. In addition, a 180° rotational symmetry condition can be applied along the top boundary or a 90° rotational symmetry condition can be applied along the top and left side of a problem. Up to 255 materials with differing nuclear properties can be placed in a problem. The conditions of continuity of flux and current are used at diffusion region interfaces, and logarithmic derivative conditions can be applied at internal boundaries for control rod descriptions. Either a normal or an adjoint calculation can be performed. The output of the code consists of the eigenvalue, group flux edits, source edit, power edit, and various integrated quantities. (auth)

13904 (LA-3801) ENDF/B FORMAT REQUIREMENTS FOR SHIELDING APPLICATIONS. Dudziak, Donald J. (comp. and ed.) (Los Alamos Scientific Lab., N. Mex.). Apr. 1967. Contract W-7405-eng-36. 52p. (ENDF-111). Dep. CFSTI.

The present (April 1967) Evaluated Nuclear Data File/B (ENDF/B) format was designed primarily to satisfy the requirements of nuclear reactor core neutronics calculations. Extensions of the format specifications are proposed to include data of interest for shielding calculations for reactor and other applications. Alternate methods of presenting the necessary data are discussed, and the correspondence of ENDF/B to the United Kingdom Atomic Energy Authority Nuclear Data File (UK) is maintained wherever practical. In the case of photon interactions, detailed formats are recommended for cross sections for secondary angular, energy, and energy-angle distributions, and for incoherent and coherent scattering atomic form factors. Format recommendations for photon production data include those for photon angular distributions, photon production multiplicities, and photon energy-angle distributions. A listing of data on photon production in Na is included. (auth)

13905 (RPI-328-100) LINEAR ACCELERATOR PROJECT ANNUAL TECHNICAL REPORT, JULY 1, 1966-SEPTEMBER 30, 1967. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. 193p. Dep. CFSTI.

Separate abstracts were prepared for the six sections presented. (W.H.K.)

For abstracts of individual sections see: 13876, 13906-13908, 14001, and 14296.

13906 (RPI-328-100, pp 57-112) FAST REACTOR PHYSICS EXPERIMENTAL. (Rensselaer Polytechnic Inst., Troy, N. Y.).

The capability for making and analyzing pulsed-source time-of-flight measurements of fast neutron spectra was developed. The efficiency and calibration of detectors were investigated. Neutron spectra in iron were measured, and position- and energy-dependent time moments were calculated for the iron assembly. The angular, energy, and spatial distributions of the neutron field in a depleted uranium assembly were investigated using the time-of-flight method. The efficiency of the collimation used for the measurements of fast neutron spectra was studied. (D.C.W.)

13907 (RPI-328-100, pp 113-19) NEUTRON THERMALIZATION: EXPERIMENTAL. (Rensselaer Polytechnic Inst., Troy, N. Y.).

A dual-disk neutron chopper for measuring time-dependent spectra in water was completed and was tested. (D.C.W.)

13908 (RPI-328-100, pp 120-39) LOW ENERGY NEUTRON INELASTIC SCATTERING (LENIS). (Rensselaer Polytechnic Inst., Troy, N. Y.).

Inelastic scattering calculations and measurements were carried out on UC and UO_2, and doubly differential scattering cross sections were measured for polyethylene and H_2O. Experiments and data analysis for inelastic scattering on some metal hydrides were completed. Techniques for multiple scattering corrections to data were developed. (D.C.W.)

13909 (WANL-TME-1617) P1-GAS: A FORTRAN IV PROGRAM FOR CALCULATING THE P-0 AND P-1 TRANSFER MATRICES FOR NEUTRON MODERATION IN A MONATOMIC GAS. Gibson, Gordon (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). May 1967. Subcontract NP-1. 66p. Dep. CFSTI.

The equations that have been solved numerically for the elastic scattering kernels are based on: the scattering being isotropic in the center-of-mass coordinate system; the scattering cross section being a constant, i.e., independent of the velocities; and the target nuclear velocities satisfying a Maxwellian distribution. Checks are provided that indicate when an inadequate energy mesh has been selected. (auth)

13910 NEUTRON SCATTERING FROM LIGHT WATER. Beyster, J. R. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 31: 254-71(1968).

The single differential cross section for neutron scattering from light water was measured over the energy range 0.006 to 10 eV. The experimental techniques for making the measurement and correcting the data to obtain an absolute cross section are discussed. It is found that the multiple scattering of neutrons in the sample constitutes a large effect, and procedures are utilized and tested for making this correction. The resulting cross sections are compared with predictions of theoretical models describing the molecular motion in water. These models include various versions of the free gas model, the Nelkin model, variations of the Haywood model, the McMurry model, and Radkowski prescription. Completely satisfactory agreement with the available neutron scattering data does not appear possible for any of the above models. The Haywood model seems to provide good agreement, however, for the widest range of data. (auth)

13911 COMPARISON OF NEUTRON TRANSPORT AND DIFFUSION THEORIES OF ISOTROPIC SCATTERING. Grover, P. S. (Univ. of Delhi); Kothari, L. S.; Ghatak, A. K. Nucl. Sci. Eng., 31: 314-17(1968).

Assuming isotropic neutron scattering in beryllium, the fundamental decay constant λ_0 and the diffusion length L were calculated both in diffusion-theory approximation and according to the transport theory. A comparison of the two results enables one to comment on the range of validity of diffusion theory in crystalline moderators. It is found, for example, that under the assumption of isotropic scattering, the two theories give results differing by less than 4% for $B^2 \lesssim 0.04\ cm^{-2}$ in the case of a pulsed-neutron problem and for $\Sigma_a < 0.05\ cm^{-1}$ in the case of a diffusion-length problem. (auth)

13912 TIME-DEPENDENT GREEN'S FUNCTIONS IN NEUTRON TRANSPORT. Kuscer, I. (London Univ.). Kernenergie, 10: 265-8(Sept. 1967).

The general properties of Green's functions of the linearized Boltzmann equation are reviewed. An expansion in exponentially decaying modes is derived, and the coefficients are shown to be represented by the adjoint eigenfunctions. (auth)

13913 SURFACE DENSITY EVALUATION OF CRITICAL ARRAY DATA. Gutman, Thomas (Westinghouse Electric Corp., Cheswick, Pa.). Nucl. Appl., 4: 121-5(Feb. 1968).

Correlations of data characterizing arrays of subcritical units that interact to render whole arrays critical show that the resulting thickness of fissile material solution contained in an array, when "smeared" over the base area of that array, can be compared to the thickness of a single homogeneous unit having a composition and shape similar to that of the array. The correlations resulted in curves that can be used to predict critical arrays of solutions or to determine safe spacing using appropriate safety factors. Although the same relation between array-smeared thickness and single-unit thickness does not appear to apply to metal systems, a useful curve that guides the determination of criteria for adequate spacing is developed. (auth)

13914 FIRST-FLIGHT COLLISION PROBABILITY METHOD FOR COMPUTING THE TRANSPORT KERNEL IN SPHERICAL GEOMETRY. Borysiewicz, Mieczyslaw (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 12: 1105-11(1967).

The use of the first-collision probability method for the numerical treatment of the linear Boltzmann equation describing the behavior of neutrons is discussed. On the basis of this method the expressions for evaluating the transport kernel for the body of any shape, in the isotropic scattering approximation are given. The final expressions for a spherical geometry are presented in the form best suited for the use in numerical codes. (auth)

13915 NEUTRON SCATTERING FROM PARAMAGNETS. Collins, M. F.; Marshall, W. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Phys. Soc. (London), 92: 390-9(Oct. 1967).

Neutron paramagnetic scattering is discussed generally in terms of the relaxation function of the magnetic system. The expansion of the scattering function $F(\kappa,\omega)$ in terms of moments of the energy transfer is evaluated to the fourth moment for the Heisenberg Hamiltonian and for limitingly high temperatures. Consideration of these moments leads to a better approximate form for the cross section at large scattering vector than the usual Gaussian form. The interpretation of experimental data is discussed, and it is shown that important inaccuracies may arise from the use of the Gaussian approximation. A procedure for making use of experimental information is given for data from both single crystals and polycrystals. In the single-crystal case it is possible to determine exchange constants to a large number of different atoms, whilst for the polycrystal it may be difficult experimentally to separate more than two different exchange constants. (auth) (UK)

13916 A NOTE ON THE PARAMAGNETIC SCATTERING OF NEUTRONS FROM AN ISING SYSTEM. Sears, V. F. (Atomic Energy of Canada, Ltd., Chalk River). Proc. Phys. Soc. (London), 92: 837-8(Nov. 1967).

The problem of neutron scattering by an Ising paramagnet at infinite temperature is shown to give rise to a solvable one-dimensional random walk problem. (auth) (UK)

13917 TIME-DEPENDENT NEUTRON SPECTRA IN GRAPHITE. Wydler, P.; Poole, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy, 21: 903-7(Dec. 1967).

The results of a measurement of the time-dependent neutron spectrum in graphite were used to compare the following graphite scattering kernels: free gas, Egelstaff 2H, Egelstaff C, Egelstaff 4A, and Young-Koppel. An improved version of the diffusion theory program SPECTIM was used. The calculations were shown to be sensitive to small differences between kernels, and systematic discrepancies were found at high energies and at low energies and very long times. (UK)

13918 SMALL-ANGLE CRITICAL MAGNETIC SCATTERING OF NEUTRONS IN IRON. Bally, D.; Grabcev, B.; Lungu, A. M.; Popovici, M.; Totia, M. (Inst. of Atomic Physics, Bucharest). J. Phys. Chem. Solids, 28: 1947-55(Oct. 1967).

Measurements were made of the temperature variation of small-angle critical scattering of 1.25-Å neutrons by iron were made. Taking into account the inelasticity of the scattering, the parameters which define the instantaneous spin correlation function of the Ornstein–Zernicke type were determined. This form of the function was found to be valid at distances larger than 15 to 20 Å. For smaller distances it was confirmed that the instantaneous correlation function has the form of a simple exponential. From the data for $T - T_C \geq 10°$ it was deduced that the temperature variation of the static magnetic susceptibility is of the form $(T - T_C)^{-(1.30\pm0.04)}$. In the immediate proximity of the critical temperature T_C no significant deviation from this dependence was noticed. (auth) (UK)

13919 NEUTRON SCATTERING SPECTROSCOPY OF LIQUIDS. Aldred, B. K.; Eden, R. C.; White, J. W. (Oxford Univ.). Discuss. Faraday Soc., No. 43, 169-83(1967).

The use of atomic substitution techniques in some preliminary studies by neutron scattering spectroscopy of the microscopic transport properties of acetic acid and methanol are described. By making selective substitution of deuterium and fluorine for the hydrogens in the CH_3 and OH groups of these molecules, the separate contributions to the quantized and diffusive motions of each were analyzed. This is possible because the substitution of fluorine or deuterium for hydrogen in a particular group reduces the scattering cross-section of that group by at least an order of magnitude. The contributions of the group motions to the neutron scattering spectrum are then correspondingly reduced. In the inelastic scattering region of the spectrum vibrational assignments could be made. In the quasi-elastic region the intensity and angular dependence of the scattering show a marked dependency on the nature of the protons substituted. In this region the results were analyzed by determining an effective molecular diffusion coefficient, and by comparing this with values from bulk-phase studies. Particular attention was devoted to the question of the extent to which intra-molecular hindered rotation contributes to the quasi-elastic scattering. (auth)

13920 RADIATION SCATTERING STUDIES OF THE STRUCTURE AND TRANSPORT PROPERTIES OF LIQUIDS. Egelstaff, P. A. (Atomic Energy Research Establishment, Harwell, Eng.). Discuss. Faraday Soc., No. 43, 149-59(1967).

The use of radiation scattering techniques to study problems in liquid state physics has several advantages. These include the detailed nature of the information which can be obtained on structural and dynamical properties, the definiteness of the interpretation which may be given to the data, and the exceedingly wide range in types of sample and experimental circumstances which can be covered. In order to deploy these advantages to the fullest requires powerful sources and special experimental methods which are still under development. A review is given of the techniques and theory of radiation scattering work, emphasizing the relation between neutron and X-ray methods. The possibility of studying electron shell movements by measuring the ratio of X-ray to neutron intensities is discussed. Broadly, the kinds of experiment fall into two classes: (a) those in which the scattered intensity is measured as a function of the momentum transferred ($\hbar Q$) by the radiation to the specimen, giving the function S(Q), and (b) those in which the intensity is measured as a function of both the momentum transferred and the energy transferred ($\hbar\omega$) by the radiation to the specimen, giving the function $S(Q,\omega)$. The former are used to obtain information on atomic positions, while the latter experiments (coupled with the former) are used to derive dynamical information. Both kinds are discussed and some methods of interpreting S(Q) and $S(Q,\omega)$ are described. Co-operative modes of motion in the system, particularly for wavelengths of the order of the spacing between atoms, may be observed as peaks in $S(Q,\omega)$. The relationship between this kind of data and general transport coefficients is discussed. In addition, the spectral density of the velocity correlation function for atomic motions may be obtained from S(Q,1), and this relationship is outlined. Only the theoretical background to the field is covered. (auth)

13921 BRILLOUIN SCATTERING OF NEUTRONS FROM LIQUIDS. Dorner, B.; Plesser, Th.; Stiller, H. (Institut fuer Neutronenphysik, Juelich, Ger.). Discuss. Faraday Soc., No. 43, 160-8(1967).

Inelastic coherent neutron scattering is termed Brillouin scattering if the momentum transferred to the scattering system is entirely taken up by collective particle motions. With this scattering, single excited states of such motions can be observed in polycrystals and in liquids in a similar way as in single crystals, provided the measurements are not too much contaminated by multiple scattering processes combining Bragg and inelastic scattering. Liquid and solid lead were investigated in this way. Comparison of the measured dispersion laws shows that at 340°C, for frequencies between 6.4×10^{11} and 2.3×10^{12} sec^{-1} and wavelengths between 7 and 21 Å, sound waves propagate in the liquid by the same mechanism as in the solid. The contaminating double scattering is predominantly determined by maxima in the distribution of frequencies of collective motions. The observed positions of such maxima indicate that transverse modes exist also in the liquid. (auth)

13922 EFFECT OF THE TIME OF FLIGHT OF NEUTRONS ON THE DECAY CONSTANT MEASUREMENTS BY THE PULSE METHOD. Cervena, J.; Bayer, R.; Schaferlingova, W. (Inst. of Nuclear Research, Czechoslovak Academy of Science, Rez). Czech. J. Phys., 17: 1098-1104(1967).

The effect of the time of flight of neutrons escaping from the moderator on the measured time dependence of the neutron density, which in turn serves for determining the decay constant α, was analyzed. The measured values of α were found to vary considerably with the distance of the detector from the moderator and also with its size described by the buckling B^2. Measurement with light water and loose diphenyl shows that the deviation in α depends also on the type of moderator. (auth)

13923 INELASTIC SCATTERING OF COLD NEUTRONS IN POLYCRYSTALLINE GRAY TIN. Myers, Vernon W. (National Bureau of Standards, Washington, D. C.). J. Phys. Chem. Solids, 28: 2207-10(Nov. 1967).

The inelastic scattering of cold neutrons by polycrystalline gray tin (diamond structure) at 0°C was investigated using the Brookhaven cold neutron facility. It was found possible to obtain information on the phonon critical points. There was a narrow peak centered at about 7-MeV phonon energy which is attributed to the transverse acoustic modes. A broad band centered around 23 MeV was probably due to a combination of the longitudinal optic and acoustic modes. The results were consistent with single crystal dispersion measurements in Si and Ge when the frequencies were scaled inversely as the square root of the mass. This indicates that the force constants in Si, Ge, and Sn have approximately the same strength. (auth) (UK)

13924 A MONTE CARLO PROGRAM FOR CALCULATION OF NEUTRON ATTENUATION AND MULTIPLE SCATTERING CORRECTIONS. Holmqvist, B.; Gustavsson, B.; Wiedling, T.

(Aktiebolaget Atomenergi, Studsvik, Sweden). Ark. Fys., 34: 481-93(1967).

A Monte Carlo program to be used to correct experimental neutron elastic scattering angular distributions is described in detail. The program corrects for neutron attenuation and multiple scattering in the sample and for the finite angular resolution of the target-scatterer and scatterer-detector geometries. The program involves facilities for calculation of the errors of the correct differential cross sections by taking into account the experimental and the computational uncertainties. The correct differential angular distribution is expressed by a Legendre polynomial expansion. The operation of the program is illustrated by examples. (auth) (Sweden)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 13631, 13928, 13945, and 14072.

13925 (AWRE-O-33/61) DECAY ENERGY OF TRITIUM. Johnston, K. (Atomic Weapons Research Establishment, Aldermaston (England)). [1961]. 24p. Dep. CFSTI. UK.

The decay energy of tritium was measured calorimetrically, yielding a value of 0.3244 ± 0.0013 absolute W/g tritium. Assuming a 12.26-year half-life, this gives values of 5.66 ± 0.04 keV for the average β energy and 18.54 ± 0.1 keV for the maximum β energy. (auth) (UK)

13926 (DESY-67/21) NEUTRON FORM FACTORS FROM ANALYSIS OF DEUTERON ELECTRODISINTEGRATION EXPERIMENTS. Hasselmann, D.; Kramer, G. (Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Sept. 1967. 19p. Dep.

Electromagnetic form factors of the neutron are calculated from recent quasielastic electron-deuteron scattering experiments done at Orsay and Stanford. The theory used in the analysis includes a realistic description of the deuteron and rescattering corrections. (auth)

13927 (USC-136-132) ANNUAL PROGRESS REPORT [ON NUCLEAR PHYSICS], OCTOBER 1, 1966-SEPTEMBER 30, 1967. (University of Southern California, Los Angeles. Nuclear Physics Lab.). Oct. 1967. Contract AT(04-3)-136. 59p. Dep. CFSTI.

Some investigations of proton-induced reactions on light and medium-weight nuclei are summarized, together with studies of the effects of nuclear reactions on the efficiency of Ge and Si detectors for protons of 5 to 150 MeV. The effect of $\Lambda N \rightleftharpoons \Sigma N$ processes on the binding energy of $_{\Lambda}H^{3}$ was studied theoretically. Scattering chambers with radii of 12 and 16 in. were developed for angular correlation and scattering experiments and for studies of few-nucleon pickup reactions. (D.C.W.)

13928 THE GROUND STATES OF ^{3}He and ^{3}H. Ananthanarayanan, K. (MATSCIENCE, Madras). pp 93-105 of Symposia on Theoretical Physics. Vol. 5. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

The photoproduction of π-mesons from ^{3}H and ^{3}He is discussed using the impulse approximation, and the sensitivity of the cross sections to the modification of the nuclear magnetic moments is investigated. The approach differs essentially from the usual approach to the magnetic moment problem of ^{3}H and ^{3}He in that the consequences of modifying the single nucleon magnetic moments are discussed rather than introducing an unknown exchange current contribution to the nuclear magnetic moment. Pion scattering by ^{3}He and ^{3}H is then considered in order to analyze the ground state structure of the three-nucleon systems. (L.B.S.)

13929 ATOMIC CAPTURE OF STOPPED π^{-} MESONS IN THE MIXTURE OF ^{3}He AND N_2. Petrukhin, V. I.; Prokoshkin, Yu. D.; Filippov, A. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1008-9(Nov. 1967). (In Russian).

The yields of π^{-} mesons stop in a mixture of ^{3}He and N_2 were measured. It was shown that the capture of π^{-} mesons by atoms of ^{3}He and N occurs proportionally to the stopping power of atoms. (auth)

13930 SEARCH FOR T = $\frac{3}{2}$ STATES IN ^{5}Li, ^{5}He, AND ^{5}H. McGrath, Robert L.; Cerny, Joseph; Cosper, S. W. (Univ. of California, Berkeley). Phys. Rev., 165: 1126-35(Jan. 20, 1968). (UCRL-17777).

Three experiments to search for T = $\frac{3}{2}$ mass-5 analog states were performed. Both triton energy spectra from the ^{7}Li(p,t)^{5}Li reaction and particle-particle coincidence data on the ^{7}Li(p,t)^{5}Li and ^{7}Li(p,^{3}He)^{5}He reactions failed to reveal well-defined ^{5}Li or ^{5}He states having expected T = $\frac{3}{2}$ properties. Tentative evidence is found from these measurements for broad T = $\frac{3}{2}$ states at 22-, 25-, and 34-MeV excitation energy. ^{8}B energy spectra from the ^{9}Be(α,^{8}B)^{5}H reaction also exhibited no peaks which might be associated with sharp states of ^{5}H. These results are qualitatively in agreement with several theoretical predictions that ^{5}H is unbound to particle emission by at least several MeV. (auth)

13931 THEORY OF THE PHOTODISINTEGRATION OF THE DEUTERON AND OF OTHER NUCLEI. Breit, G.; Rustgi, M. L. (Yale Univ., New Haven). Phys. Rev., 165: 1075-92(Jan. 20, 1968) (YALE-1807-46).

The interaction between the radiation field and a collection of nucleons is formulated in a manner suitable for the employment of the Franz-Stech classification of electromagnetic multipoles, and for separating the more certain parts of the interaction energy from the speculative ones, the uncertainties being concerned with exchange currents. The separation is effected by bringing the entrance of the electric charge density into evidence. The heuristic introduction of the intensity of magnetization as though it were due to magnetic moments of the fixed-magnetic-moment type is avoided, the whole interaction being expressed in terms of currents. Part of the general discussion neglects retardation so as to bring out the reasons for the particular grouping of terms, but retardation effects are included later on. It is shown that in a nonrelativistic theory the usual procedure of making calculations as though the center of mass of the p-n system were fixed may be justified as an approximation provided certain assumptions are made. The recoil of the center of mass caused by photon absorption is explicitly considered in this connection. Some limitations of the theory caused by relativistic effects are mentioned. The relations of contributions to the electric-multipole transition amplitudes caused by the nucleon magnetic moments, as well as of related contributions of radial components of the Schroedinger current, are discussed in relation to the retardation effects. A brief review of the limitations of space-time models and of the accomplishments of the pure S-matrix approach to the d(γ,n)p problem indicates the continued value of both approaches. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 13631, 13775, 13797, 13929, 13930, 13969, 14019, 14024, 14085, 14089, 14104, and 14116.

13932 (LYCEN-6747) (α,t) AND (α,^{3}He) REACTIONS ON ^{12}C. (Lyon Univ. (France). Institut de Physique Nucleaire). June 1967. 11p. (CONF-670629-6). Dep.

From Symposium on Light Nuclei, Few Body Problems, and Nuclear Forces, Brela, Yugoslavia.

The energy spectra of alpha particles, tritons, and ^{3}He from the bombardment of a polystyrene foil with 56-MeV alpha particles were measured together with angular distributions for the reactions ^{12}C(α,^{3}He)^{13}C and ^{12}C(α,t)^{13}N to the ground states of ^{13}C and ^{13}N and to an excited level at about 3.7 MeV. The angular distribution for elastic scattering of 56-MeV alpha particles from ^{12}C was also obtained. The angular distributions for the reactions to the ground states were analyzed using entrance channel parameters that were obtained by an optical-model fit to the elastic scattering data. The (α,^{3}He) and (α,t) reactions were also studied on ^{10}B, ^{40}Ca, ^{14}N, and ^{32}S, with emphasis on the ratios of the cross sections. It was observed that the (α,^{3}He) cross section was always larger than the (α,t) cross section; but it was not possible to attribute this effect uniquely to a Coulomb barrier, different binding energies, or different overlap integrals. (D.C.W.)

13933 (PPAD-633-F) DOUBLE CHARGE EXCHANGE SCATTERING OF POSITIVE π MESONS ON COMPLEX NUCLEI. Boynton, Paul Edward (Princeton Univ., N. J. Palmer Physical Lab. Princeton-Pennsylvania Accelerator, Princeton, N. J.). Apr. 1967. Contract AT(30-1)-2137. 173p. Dep. CFSTI.

Thesis

The differential cross section for the reaction π^{+} + N(z,n) → π^{-} + X was measured at lab angles of 7.5 and 15° with incident 200-MeV π^{+} derived from the external proton beam of the UCLRL 184" synchrocyclotron. Several target nuclei were employed: ^{51}V, ^{90}Zr, ^{7}Li. The momentum analysis of the final-state π^{-} was accomplished with a magnetic spectrometer using digitized wire spark chambers for track location. Recent theoretical papers indicate the possibility of exciting $\Delta_T^+ = 2$ isobaric analogue states (for which X = N(z + 2, n - 2)—a two body final state). The data obtained show no evidence of this state and provide an upper limit of 1 to 2 μb/sr

on its excitation at both 7.5 and 15°. The contribution to the cross section from all final states is 40 to 60 μb/sr for the various targets and angles and for 110 < T_{π^-} < 200 MeV. The discrepancy between theory and experiment is discussed in terms of a pion-complex nucleus interaction model including effects of higher-order inelastic scattering. (auth)

13934 CALCULATIONS OF ^{18}O ENERGY LEVELS WITH A VELOCITY-DEPENDENT POTENTIAL. Grote, Hans (Univ., Goettingen, Ger.). Kurznachr. Akad. Wiss. Goettingen, 2: 65-8 (1966). (In German).

A Razavy 2-particle velocity-dependent potential was used to calculate the lower levels of the ^{18}O nucleus. Only the two outer neutrons were considered. The only one-particle states allowed were the 2 lowest states of ^{17}O. One-particle wave functions were chosen to be the eigenfunctions of the three-dimensional isotropic harmonic oscillator. Matrix elements were related to Talmi integrals and were evaluated by use of Brody's tables of transformation coefficients. Calculations were made between the interval 1.2 to 2.2 fm. The interaction energy was found to be −3.923 MeV. Separations of levels at a = 1.9 fm correlate better than for a = 2.0 fm, but the interaction energy calculated for the latter fits experimental data better. Results for ^{18}F were also obtained. (BBB).

13935 THE RADIATIVE WIDTH OF THE 3.09-MeV STATE OF ^{12}C. Allen, K. W.; Lawson, P. G.; Wilkinson, D. H. (Oxford Univ.). Phys. Lett., 26B: 138-9(Jan. 8, 1968).

The mean life of the 3.09-MeV state of ^{12}C was found to be less than 20 fs in disagreement with a recently reported measurement of 55 fs. The new limit is consistent with expectations based on the mean life of the 2.37-MeV mirror state in ^{13}N. (auth)

13936 POLARIZATION EFFECTS IN THE ^{7}Li(p,α)^{4}He REACTION. Arvieux, J.; Roman, S. (Univ. of Birmingham, Eng.). Phys. Lett., 26B: 153-4(Jan. 8, 1968).

The reaction ^{7}Li(p,α)^{4}He induced by polarized protons was investigated for incident energy varied between 7.4 and 10.4 MeV The asymmetry of the α particles was measured in the plane of the reaction as a function of the reaction angle. (auth)

13937 THE 8 PARTICLE–8 HOLE ROTATIONAL BAND IN ^{16}O. Abgrall, Y.; Baron, G.; Caurier, E.; Monsonego, G. (Centre de Recherches Nucleaires, Strasbourg). Phys. Lett., 26B: 53-5 (Dec. 25, 1967).

The levels seen in the α + ^{12}C → ^{8}Be + ^{8}Be reaction are identified as members of a rotational band generated by an axially symmetric 8p−8h deformed state. The spectrum momentum out of this intrinsic state reproduces very well the experimental one. (auth)

13938 EXCITATION AND IONIZATION OF HELIUM-LIKE ATOMS IN β DECAY. Skorobogatov, G. A. (Leningrad State Univ.). Yadern. Fiz., 6: 935-44(Nov. 1967). (In Russian).

Proceeding from the variational wave functions of helium-like atoms, a formula for the probability of the ground-state (1^1S) conservation by any helium-like atom in the β decay of its nuclei is derived. The problem of the choice of the nuclear screening constant in the case of calculations in the hydrogen-like approximation was considered. For the helium β decay in the 1^1S state, the probability of multiple ionization of the lithium daughter atom was calculated to be 7.7 ± 1.2%, which differs from the value previously obtained elsewhere. (auth)

13939 ABSOLUTE NEUTRON YIELDS FROM THICK TARGET ^{NAT}C(α,n). Macklin, R. L.; Gibbons, J. H. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 31: 343(1968).

A direct measurement of the neutron yield from the (α,n) reaction on natural carbon was made at alpha energies of 2 to 11 MeV. A plateau is observed in the integral yield near 4 MeV, apparently due to the scarcity of available states in ^{17}O near excitation energies of 9.5 MeV. (D.C.W.)

13940 PRELIMINARY RESULTS OF THE INVESTIGATIONS OF THE INTERNAL BREMSSTRAHLUNG IN POSITIVE BETA-DECAY. Berenyi, Denes; Scharbert, Tibor; Vatai, Endre. ATOMKI (At. Kut. Intez.) Kozlem., 9: 267-71(Oct. 1967). (In Hungarian).

The internal bremsstrahlung in positive beta-decay was investigated in the case of ^{11}C, using a beta-gamma scintillation coincidence arrangement. Great care was used to eliminate the false coincidences coming from Compton scattering of the annihilation radiation, and measuring the chance coincidences. According to the preliminary measurements the relative intensity of the internal bremsstrahlung is about 9×10^{-3} quanta per beta-decay. This value is higher than the theoretically expected one. (auth)

13941 PRECISE DETERMINATION OF THE BRANCHING RATIO AND Q-VALUE OF THE ^{10}B(n,α)^{7}Li REACTION AND OF THE Q-VALUE OF THE ^{6}Li(n,α)^{3}H REACTION. Deruytter, A. J.; Pelfer, P. (EURATOM, Geel, Belgium). J. Nucl. Energy, 21: 833-45(Nov. 1967).

The probability of disintegration via the ground state in the ^{10}B(n,α) reaction induced by thermal neutrons was precisely determined to be 6.308 ± 0.006%. The result was corrected for epicadmium neutrons in the beam by a measurement of this ratio for epicadmium neutrons with a precision of 1 per cent. The pulse-height spectra were recorded with surface-barrier detectors, and the dimensions and geometry of the detection chamber were such that scattered particles were not registered. The Q-values of the ^{10}B(n,α) and ^{6}Li(n,α) reactions were determined by comparison of the pulse heights of the reaction products to the pulse heights of the α particles from ^{241}Am and ^{239}Pu. The results obtained are for ^{10}B(n,α)Q = 2800.8 ± 7.6 keV and for ^{6}Li(n,α)Q = 4794 ± 12 keV. (auth) (UK)

13942 THE ^{19}F(n,2n)^{18}F REACTION AS A 14-MeV NEUTRON FLUX MONITOR. Shiokawa, Takanobu; Yagi, Masuo; Kaji, Harumi; Sasaki, Teikichi (Tohoku Univ., Sendai). J. Inorg. Nucl. Chem., 30: 1-4(Jan. 1968).

Cross sections of the reaction ^{19}F(n,2n)^{18}F were measured by the radioactivation method and were determined relative to the cross sections for the reaction ^{63}Cu(n,2n)^{62}Cu in order to use fluorine as a 14-MeV neutron flux monitor. The curve of the cross section vs the incident neutron energy rose from 43.3 mbarn at 13.5 MeV to 68.4 mbarn at 14.8 MeV. (auth) (UK)

13943 FINE STRUCTURE OF THE ^{12}C(γ,n) REACTION. Fukuda, Kyue; Okabe, Shigeru; Sato, Yuji. Annu. Rep. Radiat. Center Osaka Prefect., 7: 38-40(1966).

The neutron yield curve for the ^{12}C(γ,n) reaction was studied in detail for the energy region between 4.9 and 15 MeV using an 18 MeV electron linear accelerator. Several breaks (fine structures of the cross section) appeared as changes in the slope of the yield curve at energies of 7.1, 10.4, 11.6 and 14.6 MeV distinctly, and less distinctly at 6.2 and 9.2 MeV. The existence of these breaks means that many resonances of the ^{12}C(γ,n) reaction exist below the giant resonance region. (auth)

13944 MEAN LIVES OF SOME STATES IN ^{10}B. Donahue, D. J.; Wozniak, M. J.; Hershberger, R. L.; Cummings, J. E.; Lonergan, J. A. (Univ. of Arizona, Tucson). Phys. Rev., 165: 1071-5(Jan. 20, 1968).

Doppler shifts of γ rays from some excited states of ^{10}B nuclei produced in the reaction ^{11}B(^{3}He,α)^{10}B were measured with Ge(Li) and NaI(Tl) detectors. From these Doppler shifts, the following information concerning mean lives of states in ^{10}B was deduced: τ(1.74 MeV) ≤ 4×10^{-14}sec, τ(2.15 MeV) = 2.1×10^{-12}sec, and τ(3.59 MeV) = $1.7 \pm 0.7 \times 10^{-13}$sec. (auth)

13945 TWO-NUCLEON EMISSION FOLLOWING ABSORPTION OF STOPPED NEGATIVE PIONS. Nordberg, M. E. Jr.; Kinsey, K. F.; Burman, R. L. (Univ. of Rochester, N. Y.). Phys. Rev., 165: 1096-1104(Jan. 20, 1968).

A beam of π⁻ was brought to rest in a variety of light-element targets. The angular distributions of nucleon pairs emitted in the subsequent pion absorption were measured. The angular distributions peak strongly at 180°, supporting the two-nucleon model of the absorption process. The emission of an n-p (n-n) pair implies capture of the π⁻ by a p-p (n-p) pair inside the nucleus. The ratio of n-n to n-p emission was measured to be 3.3 ± 0.9 averaged over p-shell nuclei. This is compared with predictions of this ratio which are sensitive to the two-nucleon correlation within the nucleus. Measurements of the proton spectra were made in the n-p emission and are in agreement with the two-nucleon mechanism. The branching ratio of π⁻ absorption yielding two correlated nucleons is typically 40%. (auth)

13946 STUDY OF ^{10}B (n,α)^{7}Li, ^{7}Li* FOR 30 < E_n keV < 500. Macklin, R. L.; Gibbons, J. H. (Oak Ridge National Lab., Tenn.). Phys. Rev., 165: 1147-53(Jan. 20, 1968). (ORNL-P-3381).

The cross section for ^{10}B(n,α)^{7}Li was measured by reciprocity from the inverse reaction, using the 4π "graphite sphere" neutron detector. The branching ratio to the ground and first excited states of ^{7}Li was measured using face-to-face surface-barrier silicon detectors. The resulting reaction yield, normalized ultimately to the thermal cross section, shows significant (≳2%) departure from 1/v in different directions at different energies for the two reaction channels: ≳30 keV (high) for (n,α_1), ≳100 keV (low) for (n,α_1), and ≳170 keV (low) for ($n,\alpha_0 + \alpha_1$). (auth)

13947 INADEQUACY OF THE SIMPLE DISTORTED-WAVE BORN-APPROXIMATION TREATMENT OF COMPARATIVE (p,t) AND (p,^{3}He) TRANSITIONS. Fleming, Donald G.; Cerny,

Joseph; Glendenning, Norman K. (Univ. of California, Berkeley). Phys. Rev., 165: 1153-65(Jan. 20, 1968). (UCRL-17731).

Current theories of direct two-nucleon transfer reactions are tested, by comparing (p,t) and (p,^{3}He) transitions on odd-mass nuclei leading to mirror final states. Proton-induced reactions on ^{15}N at 43.7 MeV and on ^{13}C at 49.6 MeV are discussed in detail. Many mirror transitions are analyzed with DWBA calculations in an attempt to fit both angular distributions and cross-section ratios; good results for the shapes of the angular distributions are obtained. The agreement between theory and experiment for the cross-section ratios of mirror (p,t) to (p,^{3}He) transitions improves in every case with the inclusion of a strongly spin-dependent force in the nucleon-nucleon interaction, but over-all satisfactory agreement is not obtained. The (p,t) transitions are found to be generally stronger than expected, relative to their mirror (p,^{3}He) transitions, and three cases are discussed where the experimental ratios of these cross sections exceed the theoretical upper limit. Two possibilities, both of which introduce coherent effects, are discussed to account for this result: interference terms arising through a spin-orbit interaction in the optical potential or interference terms between a direct-reaction contribution and a core-excitation contribution to the cross section. (auth)

13948 ISOBARIC ANALOG STATES OF ^{15}N AND ^{15}O. Beaumevieille, H. (Institut d'Etudes Nucleaires, Algiers); Lambert, M.; Yaker, M.; Amokrane, A.; Nguyen Van Sen. Nuovo Cim. (10), 53B: 226-8(Jan. 11, 1968). (In French).

Angular distributions for the reaction ^{14}N(d,p)^{15}N to four states of ^{15}N were measured for deuteron energies between 1.0 and 3.2 MeV. The angular distributions were analyzed using the distorted-wave Born approximation, and spectroscopic factors were obtained. The spectroscopic factors were compared with values obtained for ^{15}O using the ^{14}N(d,n)^{15}O reaction and with the predictions of the shell model. (D.C.W.)

13949 ATTENUATED MAGNETIC TRANSITIONS IN SELF-CONJUGATE NUCLEI. Jang, S. (Centre de Recherches Nucleaires, Strasbourg). J. Phys. (Paris), 28: 871-80(Nov.-Dec. 1967). (In French).

Some attenuated magnetic dipole and quadrupole transitions with $\Delta T = 0$ in ^{12}C and ^{16}O are examined by establishing a close relation between the inelastic scattering matrix element of high-energy protons in the framework of the impulse approximation at small angles and electromagnetic transitions. The distorted-wave effects are taken into account. (auth)

13950 PHOTODISINTEGRATION OF CARBON, REACTION (γ,p). Taran, G. G.; Gorbunov, A. N. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 6: 1124-33(Dec. 1967). (In Russian).

The effective cross section of the (γ,p) reaction on carbon and the proton angular distributions were measured using a cloud chamber at the maximal energy 170 MeV of the bremsstrahlung photons. Levels were detected with excitation energy of more than 30 MeV that contribute 16% to the integral cross section of the (γ,p) reaction up to 37 MeV. The integral cross section for photon absorption is found to be 345 ± 28 MeV · mbarn up to 170 MeV. (auth)

13951 CAPTURE OF π^- MESON BY CARBON NUCLEI AND TETRANEUTRON. Batusov, Yu. A.; Bunyatov, S. A.; Sidorov, V. M.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1149-50(Dec. 1967). (In Russian).

The capture of π^- mesons by photoemulsion nuclei with the production of ^{8}Li and ^{8}B was investigated. One-prong events were analyzed to separate the reaction $\pi^- + {}^{12}C \rightarrow {}^8B + n^4$. It has been found that the relative probability of the reaction involving the production of tetraneutron at the capture of π^- mesons by the carbon nuclei is less than 2.6×10^{-6}. (auth)

13952 PRODUCTION OF ^{8}Li AT THE CAPTURE OF SLOW π^- MESONS BY THE NUCLEI OF CARBON, NITROGEN, AND OXYGEN. Batusov, Yu. A.; Bunyatov, S. A.; Sidorov, V. M.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1151-7(Dec. 1967). (In Russian).

By means of photoemulsions, two- and three-particle reactions involving the production of ^{8}Li and ^{8}B nuclei in the capture of π^- mesons by carbon, nitrogen, and oxygen nuclei were investigated. It has been found that the relative probabilities of two-particle disintegration of light nuclei is less than 2 to 10×10^{-4}. The probability of the reaction $\pi^- + {}^{12}C \rightarrow {}^8Li + {}^3He + n$ appeared to be 2.2×10^{-4}, while the reaction $\pi^- + {}^{16}O \rightarrow {}^8Li + {}^7Be + n$ was strongly suppressed. Energy spectra and angular correlations of secondary particles for the reaction $\pi^- + {}^{12}C \rightarrow {}^8Li + {}^3He + n$ were measured. It was established that at the capture of π^- mesons by light nuclei, the mechanism of direct capture on few-nucleon associations is of great importance; this is in agreement with the theory of nuclear reactions. (auth)

13953 PRODUCTION OF ^{3}He AT INTERACTION OF THE 660-MeV PROTONS WITH LIGHT NUCLEI. Kuz'min, V. N.; Yakovlev, R. M. Yadern. Fiz., 6: 1158-61(Dec. 1967). (In Russian).

Kinematic characteristics of the ^{3}He production were studied with nuclear emulsions. The ^{3}He isotope was identified by counting grains in the emulsion. The angular and energy spectra of ^{3}He are shown to be satisfactorily explained in terms of the interaction between the proton and the α-clusters in light nuclei. The effective number of α particles inside the nuclei is estimated. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 12338, 13226, 13927, 13933, 14001, 14019, 14020, 14024, 14026, 14034, 14066, 14082, and 14113.

13954 (AE-303) NEUTRON ELASTIC SCATTERING CROSS SECTIONS OF THE ELEMENTS, Ni, Co, AND Cu, BETWEEN 1.5 AND 8.0 MeV. Holmqvist, B.; Wiedling, T. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Dec. 1967. 17p. Dep.

Angular distributions of elastically scattered neutrons were measured for natural nickel at seven energies between 3.0 and 8.1 MeV and for cobalt and copper at ten energies between 1.5 and 8.1 MeV, by using the time-of-flight technique. The observed angular distributions were corrected for neutron flux attenuation, multiple elastic scattering, and the finite geometry of the source-sample-detector system by using a Monte Carlo computer program. Theoretical angular distributions were fitted to the experimental angular distributions by using an optical model potential of the form $-V(r) = Uf(r) + iWg(r) + U_{so}(\hbar/\mu_\pi c)^2\ 1/r\ d/dr\ |f(r)|\vec{\sigma}\cdot\vec{l}$ with Saxon–Woods form factors. A computer program was used to find parameter values of the potential giving the best fittings to the experimental angular distributions. (auth) (Sweden)

13955 (COO-1468-2) [NUCLEAR PHYSICS]. Progress Report, January 1967–December 1967. Donahue, D. J.; McCullen, J. D.; McIntyre, L. C. (Arizona Univ., Tucson). Contract AT (11-1)-1468. 8p. Dep. CFSTI.

The determination of unattenuated Doppler shifts for nuclear γ transitions was investigated. Doppler shifts of γ rays from ^{20}F, ^{26}Mg, and ^{29}Si were measured; values for the lifetimes of states in ^{20}F and ^{29}Si were obtained. The energy levels of ^{42}Sc were investigated using the reaction ^{40}Ca(He-3,p)^{42}Sc, and an experimental attempt to observe isobaric spin mixing in the decay of ^{42}Sc was begun. Development of the polarized ion source continued. (D.C.W.)

13956 EXCITATION OF COLLECTIVE NUCLEAR LEVELS IN INELASTIC DEUTERON SCATTERING. Ismatov, E. (Inst. of Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 37-40(1967). (In Russian).

The inelastic scattering of deuterons on even-even semitransparent nuclei with excitation of the first collective levels is investigated within the diffraction approximation. The nuclear and coulombic interactions are taken into account. An expression is obtained for the inelastic scattering amplitude with excitation of the 2^+ and 3^- levels. The experimental angular distributions of inelastically scattered 13.6 MeV deuterons on ^{28}Si, ^{48}Ti, ^{64}Zn, ^{56}Fe, ^{58}Ni, and ^{60}Ni are plotted and compared with calculated values. The agreement of theory with experiment is satisfactory for angles up to 80°. The stable deformation of the nucleus or the amplitude of zero oscillations near the equilibrium form is designated as β. Calculated values of β agree well with experimental values. (TTT)

13957 THE MEAN ENERGY LEVEL WIDTH Γ OF THE NUCLEI ^{27}Al AND ^{28}Al AT HIGH EXCITATION ENERGY. Bjoerlykke, J.; Grotdal, T.; Nyboe, K.; Opedal, T.; Singstad, I. (Univ. Bergen). Arbok Univ. Bergen, Mat.-Natur. Ser., No. 7, 1-24 (1967).

For the reactions ^{25}Mg(d,p)^{26}Mg and ^{26}Mg(d,p)^{27}Mg, excitation functions have been measured at five angles in steps of 10 keV in the energy range between 900 and 1600 keV. The transitions to the first, second, and fourth excited states, and an unresolved proton group consisting of transitions to the fifth, sixth and seventh excited states in ^{26}Mg were studied, as well as the transitions to the ground state and the first excited states in ^{27}Mg. The average coherence energy Γ is found to be 41 ± 8 keV in the compound

nucleus ^{27}Al at an excitation energy of 18 to 19 MeV, and 36 ± 7 keV in the compound nucleus ^{28}Al at an excitation energy of 14 to 15 MeV. (auth)

13958 HALF-LIFE AND g-FACTOR MEASUREMENT OF AN EXCITED STATE IN ^{79}Kr. Bleck, J.; Haag, D. W.; Leitz, W.; Ribbe, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Phys. Lett., 26B: 134-5(Jan. 8, 1968).

^{79}Kr* nuclei (E_x = 148 keV) were produced and aligned with the reaction ^{79}Br(p,n)^{79}Kr. From the decay and the Larmor precession in an external field, $\tau_{\frac{1}{2}}$ = 77.7 ± 1.5 ns and g = +0.449 ± 0.004 were deduced. The results are discussed in order to get spin and parity assignments for the new level. (auth)

13959 THE ^{58}Ni(^{3}He,p)^{60}Cu REACTION. Young, Helen J.; Rapaport, J. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Lett., 26B: 143-5(Jan. 8, 1968). (MIT-2098-396).

The reaction ^{58}Ni(^{3}He,p)^{60}Cu was investigated at 13.0-MeV bombarding energy. A level scheme of ^{60}Cu was obtained. The ground-state isobaric analog of ^{60}Ni in ^{60}Cu was identified. L values were obtained for the strongest transitions. (auth)

13960 EXCITATION OF PROTON HOLE STATES IN ^{43}Ca BY THE ^{41}K(^{3}He,p)^{43}Ca REACTION. Dorenbusch, W. E.; Dao, F. T.; Rapaport, J.; Belote, T. A. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett., 26B: 148-9(Jan. 8, 1968).

The reaction ^{41}K(^{3}He,p)^{43}Ca was investigated at a bombarding energy of 13.0 MeV. Results for the 4p−1h states are presented. The proton hole-state strength function for ^{43}Ca is compared with that of ^{41}Ca. (auth)

13961 DENSITY DEPENDENT FORCES AND THE NATURE OF THE ^{28}Si GROUND STATE. Manning, M. R.; Volkov, A. B. (McMaster Univ., Hamilton, Ont.). Phys. Lett., 26B: 60-2(Dec. 25, 1967).

The ^{28}Si ground state is found to be prolate when density dependent forces are used in Hartree−Fock calculations instead of oblate as in the case for non-density dependent forces. (auth)

13962 PROTON BOMBARDMENT OF THE ^{41}K ISOTOPE AT E_p = 1400 to 1750 keV. Luukko, Antii (Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A VI, No. 249, 1-14(1967).

The ^{41}K(p,n)^{41}Ca, ^{41}K(p,γ)^{42}Ca, and ^{41}K(p,α)^{38}Ar reactions were studied in the energy region E_p = 1400 to 1750 keV; 74 resonances were observed. Gamma-ray spectra were recorded from some resonances. The angular distributions of α_0 particles were measured at 8 resonances. The analysis allowed unique spin for 5 resonances. (auth)

13963 DOUBLE BETA DECAY IN ^{48}Ca AND THE CONSERVATION OF LEPTONS. Bardin, R. K.; Gollon, P. J.; Ullman, J. D.; Wu, C. S. (Columbia Univ., New York). Phys. Lett., 26B: 112-16(Dec. 25, 1967).

A new experimental investigation of double beta decay in ^{48}Ca using apparatus of unique sensitivity and discrimination is reported. A lower limit of 1.6×10^{21} years at a statistical confidence level of 80% for the lifetime of the lepton-nonconserving neutrinoless mode is obtained and of 3×10^{19} years for the lepton-conserving two-neutrino mode. (auth)

13964 THE γ-RAY SPECTRUM FROM THE REACTION ^{67}Zn(n,γ)^{68}Zn INDUCED BY THERMAL NEUTRONS. Bystrov, G. N.; Rudak, E. A.; Firsov, E. I. (Inst. of Physics, Minsk). Yadern. Fiz., 6: 906-9(Nov. 1967). (In Russian).

The γ-ray spectrum from the ^{67}Zn(n,γ)^{68}Zn-reaction induced by thermal neutrons was investigated. The magnetic Compton γ spectrometer with 2% resolution was used. On the basis of the data obtained, a scheme is presented of γ transitions from the initial state of the ^{68}Zn nucleus. (auth)

13965 TRIPLE γγγ CORRELATIONS OF γ RAYS FROM THE DECAY OF THE RESONANT STATE OF ^{27}Al WITH E = 10.480 MeV. Koval, A. A.; Kopanets, E. G.; Korda, Yu. S.; Sukhotin, L. N.; Tsytko, S. P. Yadern. Fiz., 6: 886-92(Nov. 1967). (In Russian).

The γ spectrum from the decay of the resonant state of the ^{27}Al nucleus with excitation energy 10.480 MeV from the reaction ^{24}Mg(p,γ)^{27}Al was investigated. Triple angular correlations of γ rays for the cascades 10.480 → 2.212 → 0 and 10.480 → 3.951 → 0 in two geometries were measured by means of a two-crystal summing spectrometer as well as the angular distribution of γ rays of the ground-state transition. The spins of the resonant level and of the level with the energy 3.951 MeV are shown. The coefficients of the multipole mixture for γ rays corresponding to the transitions 10.480 → 2.212 and 10.480 → 3.951 → 0 are given. (auth)

13966 MEASUREMENT OF SOME (n,n′γ)-CROSS-SECTIONS AND THEIR CONNECTION WITH THE (n,2n)-REACTION MECHANISM. Bornemisza-Pauspertl, P.; Hille, P. ATOMKI (At. Kut. Intez.) Kozlem., 9: 277-80(Oct. 1967).

The (n,n′γ) cross sections for the production of short-lived isomers of ^{79}Br, ^{89}Y, ^{176}Yb, and ^{197}Au with 14.7-MeV neutrons were measured and are discussed together with theoretical predictions of the isomeric ratios. The connection of the results with the (n,2n) reaction mechanism is discussed. (S.F.L.)

13967 ^{53}Cr(p,p′γ)^{53}Cr AND ^{53}Cr(p,nγ)^{53}Mn REACTIONS. Abuzeid, M. A.; El-Zaiki, M. I.; Mansour, N. A.; Popov, A. I.; Saad, H. R.; Storizhko, V. E. (Atomic Energy Establishment, Cairo). Ann. Phys. (Leipzig), (7), 20: 162-7(1967).

Total yields and angular distributions of 380-keV gamma rays from the ^{53}Cr(p,nγ)^{53}Mn reaction were measured for proton energies below 2.5 MeV. The experimental results are in good agreement with predictions of the statistical compound-nucleus theory. The angular distributions of 560 keV gamma rays upon the proton inelastic scattering on ^{53}Cr at E_p = 2.3, 2.4, and 2.5 MeV are isotropic, which is commensurate with a $\frac{1}{2}^{-}$ assignment to the first excited state of ^{53}Cr. (auth)

13968 PRECESSION MEASUREMENTS OF THE 0.847-MeV LEVEL OF ^{56}Fe IMPLANTED IN IRON AFTER A (p,p′) REACTION. Kalish, R.; Kossler, W. J. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev. Lett., 20: 271-4(Feb. 5, 1968).

The first excited 2^{+} level of ^{56}Fe was excited by proton inelastic scattering, and the precession of this level in the internal field in polarized iron was measured. Proton−gamma (847 keV) angular correlations were recorded as well as the angular distribution of the 847-keV gamma radiation. Three sets of precession measurements were made yielding three values for the precession angles and one value for the internal magnetic field. (D.C.W.)

13969 ELECTRON BACKSCATTERING AND SECONDARY ELECTRON EMISSION FROM SEMI-INFINITE SOLID TARGETS. Okabe, Shigeru; Tabata, Tatsuo; Ito, Rinsuke. Annu. Rep. Radiat. Center Osaka Prefect., 7: 27-30(1966).

Backscattering and secondary electron emission with 3.2 to 14.1 MeV monoenergetic electrons normally incident on semi-infinite targets of atomic number 4 to 92 were experimentally investigated. Observed angular distributions of backscattered electrons show a trend similar to Dressel's result, but backscattering coefficients obtained are lower than his values and consistent with those reported by other previous authors. The secondary emission coefficient increases with increasing atomic number except for beryllium and uranium. From these data, the incident electron current can be precisely estimated from observed target current for practical irradiations with electron accelerators. (auth)

13970 NUCLEAR LEVEL 0^{+} OF ^{42}Ca AND ^{44}Ca. Azuma, Toshio; Sato, Yuji. Annu. Rep. Radiat. Center Osaka Prefect., 7: 18-20(1966).

Energies levels in ^{42}Ca and ^{44}Ca were studied using a gamma−gamma sum coincidence technique. The spectra were compared with those of the known spectra of ^{46}Sc, ^{56}Mn, ^{76}As, and ^{88}Y by plotting angular correlation coefficients on a Coleman figure. (S.F.L.)

13971 MASSES AND DECAY OF ^{24}Al, ^{28}P, ^{32}Cl, ^{40}Sc, AND THEIR T_z = 0 ANALOG STATES. Armini, Anthony J.; Sunier, Jules W.; Richardson, J. Reginald (Univ. of California, Los Angeles). Contract Nonr-233-44. Phys. Rev., 165: 1194-1202 (Jan. 20, 1968).

The β spectra and γ transitions in the decay of ^{24}Al, ^{28}P, ^{32}Cl, and ^{40}Sc, produced by the (p,n) reaction in the UCLA sector-focused cyclotron, were measured with a wedge-gap magnetic spectrometer and a 3-cm^3 lithium-drifted germanium detector. An on-line SDS-925 computer was used to separate, by half-life analysis, the activity of interest from longer-lived contaminants. The half-lives were measured to an accuracy of 0.5% and decay schemes are proposed. The ground-state masses are determined to 25 to 40 keV. In all cases, observation of a superallowed β transition unambiguously determines the T = 1, T_z = 0 analog state. The excitation energies of these analog states are measured to an accuracy of 3 keV. Mass relations are used to predict from these data the excitation energy of the first T = 2, T_z = 0 analog states. (auth)

13972 NUCLEAR-REACTION STUDIES IN THE STRONTIUM ISOTOPES: THE ^{88}Sr(d,p)^{89}Sr REACTION. Cosman, E. R.; Enge, H. A.; Sperduto, A. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 165: 1175-83 (Jan. 20, 1968). (MIT-2098-383).

The ^{88}Sr (d,p)^{89}Sr reaction was studied at 7.0 MeV using the

MIT–ONR Van de Graaff generator and the multiple-gap spectrograph. Eighty-five levels in ^{89}Sr below 5.86-MeV excitation were identified, compared with the 12 levels below 4.1-MeV excitation recorded previously from (d,p) studies. Among the 85 levels observed, 28 were populated by direct stripping transitions; and the data were used for determining the detailed fractionization of the single-particle strength in this energy region. A distorted-wave Born-approximation analysis was performed in these cases to determine the values of the orbital angular momentum l_n and spectroscopic strengths $(2J + 1)S_{l_n,j}$ for the transferred neutron. Sum-rule strengths were subsequently calculated and compared with shell-model limits. Detailed angular distributions for some of the nonstripping states are also presented. An averaged strength function for these weaker transitions is shown and is discussed in terms of possible intermediate structure. (auth)

13973 MASS DIFFERENCE OF ^{40}K AND ^{40}Ar. Schroder, I. G. (National Bureau of Standards, Washington, D. C.); McKeown, M.; Scharff-Goldhaber, G. Phys. Rev., 165: 1184-9 (Jan. 20, 1968).

The mass difference ^{40}K–^{40}Ar and the electron-capture (EC) decay energy of ^{40}K to the first excited state (2+) of ^{40}Ar were obtained from a measurement of the Q-value of the exothermic reaction ^{40}K(n_{th},p)^{40}Ar. The following reactions were observed, and their Q-values were determined: ^{40}K(n,p_0)^{40}Ar (2.270 ± 0.005 MeV), ^{40}K(n,p_1)^{40}Ar (0.811 ± 0.005 MeV), ^{40}K(n,α)^{37}Cl (3.866 ± 0.007 MeV), and, for comparison, ^{35}Cl(n,p)^{35}S (0.612 ± 0.004 MeV). From the reaction ^{40}K(n,p_0)^{40}Ar the values 1.488 ± 0.005 MeV and 27 ± 5 keV, respectively, were obtained for the ^{40}K–^{40}Ar mass difference and the EC decay energy of ^{40}K. The cross sections of the observed reactions were determined relative to the ^{14}N(n,p)^{14}C reaction cross section, yielding the values: ^{40}K(n,p_0)^{40}Ar (4.30 ± 0.34 b), ^{40}K(n,p_1)^{40}Ar (0.127 ± 0.016 b), ^{40}K(n,α)^{37}Cl (0.388 ± 0.032 b), and ^{35}Cl(n,p)^{35}S (0.446 ± 0.040 b). (auth)

13974 SPALLATION YIELDS OF KRYPTON AND XENON FROM IRRADIATION OF STRONTIUM AND BARIUM WITH 730-MeV PROTONS. Funk, H.; Podosek, F.; Rowe, M. W. (Univ. of California, Berkeley). Earth Planet. Sci. Lett., 3: 193-6 (Dec. 1967). (UCB-34-P-32-61).

The krypton and xenon isotopes resulting from spallation of strontium and barium by 730-MeV protons were studied mass spectrometrically. The cross sections for chain yields of 7 krypton isotopes (2 radioactive) and 9 xenon isotopes (1 radioactive) are reported. (auth)

13975 STUDY OF THE (d,p) REACTION ON ^{70}Ge. Goldman, L. H. (Univ. of Pittsburgh). Phys. Rev., 165: 1203-8 (Jan. 20, 1968).

The reaction ^{70}Ge(d,p)^{71}Ge was studied at a bombarding energy of 7.5 MeV using the MIT Van de Graaff accelerator and multigap spectrograph with photographic-plate detectors. With an energy resolution of 25 keV, 86 levels were identified up to an excitation energy of 4.5 MeV. The angular distribution of the proton groups showing stripping characteristics were analyzed by use of the distorted-wave Born approximation, and values of orbital-angular-momentum transfer l_n were assigned to approximately 40 levels. For $l_n = 1$ levels, j values were determined by the Lee–Schiffer effect. The sum of the spectroscopic factors (occupation number) for the 28 to 50-neutron shell are $p_{\frac{1}{2}}$-0.5, $p_{\frac{3}{2}}$-0.03, $f_{\frac{5}{2}}$-0.3, and $g_{\frac{9}{2}}$-0.7. Single-quasiparticle energies for the same shell are approximately $E_{\frac{1}{2}} = 0.2$, $E_{\frac{3}{2}} = 0.30$, $E_{\frac{5}{2}} = 1.3$, and $E_{\frac{9}{2}} = 2.0$ MeV. The occupation numbers are compared with those of neighboring nuclei and pairing theory. The results indicate that in the region of 36 to 42 neutrons, the neutrons go predominantly into the $g_{\frac{9}{2}}$ state. (auth)

13976 ^{40}Ca(α,$\alpha'\gamma$) FOR STATES AT 6.29, 6.56, AND 6.94 MeV. Kossler, W. J. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 165: 1209-14 (Jan. 20, 1968).

Gamma rays from ^{40}Ca(α,$\alpha'\gamma$) were studied using 31-MeV α particles detected in a solid-state detector subtending 4.5×10^{-3} sr at 30° from the beam axis. The states studied are at 6.29, 6.56 (3^- states), and 6.94 MeV. For the 6.94-MeV state, an angular correlation of the ground-state branch is reported which lends support to the 1^- assignment from the (α,α') angular distribution at a bombarding energy of 31 MeV. (auth)

13977 LIFETIME OF THE FIRST EXCITED STATE OF ^{32}P. Mendelson, R. A. Jr.; Carpenter, R. T. (Univ. of Iowa, Iowa City). Phys. Rev., 165: 1214-17 (Jan. 20, 1968).

The mean life of the first excited state of ^{32}P(77 keV, 2^+) was measured to be 5.2×10^{-10} sec. The state was formed by the ^{31}P(d,p)^{32}P reaction. The time differences between the detection of a proton in a solid-state detector and a 77-keV γ ray in a NaI(Tl) crystal were measured. The prompt time distribution was obtained in a similar way using the transition between the second and first excited states of ^{24}Na excited by the ^{23}Na(d,p)^{24}Na reaction. The data were analyzed using the third-moment method. An upper limit of 5×10^{-10} sec was obtained for the mean life of the second excited state of ^{24}Na. The result obtained for ^{32}P indicates that pure j-j coupling is not an adequate description for the two lowest states in this nucleus. (auth)

13978 21-MeV ALPHA-PARTICLE SCATTERING ON A = 58 TO 64 TARGETS. Fulmer, C. B. (Oak Ridge National Lab., Tenn.); Benveniste, J.; Mitchell, A. C. Phys. Rev., 165: 1218-32 (Jan. 20, 1968).

Cross sections for 21-MeV α elastic and inelastic scattering to the first 2+ level were measured at 3° intervals between 30 and 166° for ^{58}Fe, ^{58}Ni, ^{62}Ni, ^{64}Ni, and ^{64}Zn. Both the elastic and inelastic scattering data exhibit well-defined oscillations which obey the Blair phase rule throughout the angular range. Optical-model fits to the elastic scattering data were found at intervals corresponding to the half-wavelength rule for a wide range of real-well depth. Analysis of the data indicates that the scattering is concentrated in the nuclear surface but is also sensitive to the interior of the nuclear potential. Distorted-wave calculations of the inelastic angular distributions with parameters obtained from optical-model analysis of the inelastic scattering data gave good agreement with the data in the forward hemisphere, although good agreement was not generally obtained at large angles, where the inelastic scattering cross sections are comparable to the elastic scattering cross sections. Comparison of the inelastic data with distorted-wave calculations does not remove the ambiguity of the optical-model potential. (auth)

13979 TEST OF TIME-REVERSAL INVARIANCE IN THE REACTIONS ^{24}Mg + d ⇌ ^{25}Mg + p. Weitkamp, William G.; Storm, Derek W.; Shreve, D. C.; Braithwaite, Wilfred J.; Bodansky, D. (Univ. of Washington, Seattle). Phys. Rev., 165: 1233-44 (Jan. 20, 1968). (RLO-1388-37).

No evidence for a violation of time-reversal (T) invariance was found in a study of the inverse reactions ^{24}Mg + d ⇌ ^{25}Mg + p using approximately 10-MeV deuterons and 15-MeV protons. In order to reduce systematic uncertainties, the reactions were compared by measuring, as a function of incident energy, the ratio of differential cross sections at angles corresponding to maxima in the angular distributions. Particular attention was paid to accurately determining solid angles, peak areas, counter efficiencies, electronic efficiencies, contributions of target impurities, and beam energies. Ratios for the two reactions agree to within an over-all uncertainty (standard deviation) of 0.3%. Lack of an adequate model for the reaction makes quantitative interpretation of the result difficult. However, a tentative upper limit of 0.3% is set on the ratio of the T-noninvariant to T-invariant reaction amplitudes. (auth)

13980 SPINS AND LIFETIMES OF THE 6.91- AND 6.95-MeV EXCITED STATES OF ^{40}Ca. Metzger, F. R. (Bartol Research Foundation of the Franklin Inst., Swarthmore, Pa.). Phys. Rev., 165: 1245-50 (Jan. 20, 1968). (NYO-3525-24).

Resonant scattering of γ rays by the 6.91- and 6.95-MeV excited states of ^{40}Ca was observed with a 30-cm^3 Ge(Li) detector. The reaction ^{19}F(p,α)^{16}O served as the source of the resonant γ rays. The angular distributions of the 6.91- and 6.95-MeV radiations were found to be compatible only with the assignment of spin 2 to the 6.91-MeV level, and of spin 1 to the 6.95-MeV level. No evidence for cascade de-excitation of the two levels was found. If Γ_θ/Γ is assumed to be unity for both levels, the observed scattering cross sections correspond to ground-state transition widths $\Gamma_\theta(6.91) = 0.18 \pm 0.03$ eV and $\Gamma_\theta(6.95) = 0.47 \pm 0.06$ eV. (auth)

13981 INELASTIC SCATTERING OF 42-MeV ALPHA PARTICLES BY ^{24}Mg. Naqib, I. M.; Blair, J. S. (Univ. of Washington, Seattle). Phys. Rev., 165: 1250-63 (Jan. 20, 1968).

Angular distributions for elastic and inelastic scattering of 42-MeV α particles by ^{24}Mg were measured in the range θ(lab) = 10 to 60°. Eight inelastic α groups were identified with the following Q-values: 1.37, 4.16 (doublet), 5.22, 6.005, 6.44, 7.35, 7.62, and 8.37 MeV. Two theoretical models, the distorted-wave Born-approximation version of the extended optical model and the smoothed Fraunhofer inelastic diffraction model, have comparable degrees of success in fitting the observed angular distributions. Further, extracted values of the deformation distances $\delta_\lambda \equiv \beta_\lambda R_\theta$, which parametrize the nuclear matrix elements, show good agreement between the two methods of analysis for low Q-values and angular momentum transfer; as these quantities increase, however, the smoothed Fraunhofer model tends to underestimate δ_λ by as much as 30%. The present results on the nature and strength of the transitions to the positive-parity levels at 1.37, 4.16 (doublet), 5.22, 6.005, 6.44, and 7.35 MeV are in agreement with the broad features of the rotational-vibrational collective-model predictions for these levels, but not with its literal interpretation in terms of

macroscopic quadrupole surface excitations of the nuclear intrinsic states. The present results indicate the presence of the two 3⁻ levels, strongly collective in nature, at 7.62 and 8.37 MeV. Comparisons are made with other experiments of similar nature on the ^{24}Mg nucleus. (auth)

13982 DECAY OF ^{86}Rb BY ELECTRON CAPTURE. Alexander, E. C. Jr. (Univ. of Missouri, Rolla); Manuel, O. K.; Ganapathy, R. Contract AT(40-1)-3235. Phys. Rev., 165: 1264 (Jan. 20, 1968).

The decay of ^{86}Rb by electron capture was determined by measuring the abundance of ^{86}Kr produced in a pile-irradiated rubidium salt. A branching ratio of $\lambda_{EC}/\lambda_{\beta^-} = 5.24 \pm 0.52 \times 10^{-5}$ for ^{86}Rb was obtained by comparing the excess ^{86}Kr with excess ^{80}Kr from the internal bromine monitor and with the ^{86}Rb activity. (auth)

13983 RESONANCES IN EXCITATION FUNCTIONS FOR THE SCATTERING OF PROTONS ON ^{27}Al AT 6.5 MeV. Vasil'ev, S. S.; Vorob'ev, Yu. A.; Mikhaleva, T. N.; Chuprunov, D. L. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 6: 1134-6(Dec. 1967). (In Russian).

In each function for the channels p_0, p_{1+2}, p_3, p_4, and p_{5+6} measured in proton scattering on ^{27}Al ($6.21 < E_p < 6.74$ MeV), six resonances were observed correlating both between the reaction channels and in the each channel at different observation angles. The mean values of distances between the resonances and their widths are 94 ± 5 and 88 ± 5, respectively. The probable nature of the resonances observed in the excitation in the intermediate system of isobaric analogous states. (auth)

13984 REACTION ^{54}Cr(d,p)^{55}Cr AT THE DEUTERON ENERGIES 12 AND 6.8 MeV. Litvin, V. F.; Nemilov, Yu. A.; Zherebtsova, K. I.; Gridnev, K. A.; Krasnov, L. V.; Lakomkin, Yu. A.; Orlova, T. V.; Shchedrina, M. V.; Sitnov, V. I. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 6: 1137-41(Dec. 1967). (In Russian).

Energy spectra of protons emitted from the ^{54}Cr nucleus bombarded by deuterons with energy 6.8 and 12.0 MeV were measured for several values of the emission angle θ. Indications are obtained that the cascade process ^{54}Cr(d,n)^{55}Mn → ^{54}Cr + p may exist. The intensity of the soft part of the proton spectrum that corresponds to weakly bound states of the neutron in the nucleus increases sharply from $E_d = 6.8$ to 12.0 MeV. A possible explanation of the intensity increase in framework of the distorted-wave approximation is discussed. (auth)

13985 SHAPE OF ISOTOPIC TERM IN THE POTENTIAL OF SELF-CONSISTENT FIELD. Gorodkov, S. S.; Nemirovskii, P. E. Yadern. Fiz., 6: 1184-5(Dec. 1967). (In Russian).

One-particle levels of nuclei with $N_{mag} \pm 1$ number of nucleons are calculated assuming the surface shape of the isotopic term of the shell potential. (auth)

13986 INVESTIGATION OF INTERACTION OF K_L^0 MESONS (MEAN ENERGY 120 MeV) WITH NUCLEI Ar, Cu, AND Pb. Vardenga, G.; Zhuravleva, M.; Kotlyarevskii, D.; Novikov, V.; Okonov, E.; Takhtamyshev, G.; Chkhaidze, L. (Joint Inst. for Nuclear Research, Dubna, USSR. Inst. of Physics, Tbilisi, USSR). Yadern. Fiz., 6: 1215-20(Dec. 1967). (In Russian).

The cross sections of the $\Lambda^0(\Sigma^0)$ hyperon production by K_L^0 mesons with the mean energy 120 MeV on the nuclei Ar, Cu, and Pb were determined. The momentum and angular distributions obtained for the Λ^0 hyperons produced are shown to be in good agreement with the model of the cascade interactions of particles. (auth)

13987 TOTAL CROSS SECTIONS OF Na, K, AND Ca FOR 14-MeV NEUTRONS. Guarrini, F.; Luches, A.; Pauli, G.; Poiani, G. (Istituto Nazionale di Fisica Nucleare, Trieste, Italy. Univ., Trieste, Italy). Nucl. Sci. Eng., 31: 341-3(1968).

The neutron total cross sections of Ca, K, and Na were measured by the transmission method using 14.68-MeV neutrons from the T(d,n)^{4}He reaction. Corrections for background and inscattering were applied. (D.C.W.)

13988 ENERGY LEVELS IN THE SINGLE CLOSED SHELL NUCLEUS ^{87}Rb. Holm, G. (Research Inst. of National Defence, Stockholm. Research Inst. for Physics, Stockholm). Ark. Fys., 34: 433-45(1967).

The decay of 1.3-hour ^{87}Kr leading to the excited states in ^{87}Rb was studied by a combination of lithium-drifted germanium detector and scintillation coincidence techniques using electromagnetically separated samples. A level scheme was constructed with states at 0, 403, 845, 1578, 1741, 2416, 2557, and 3310 keV. The general level structure is in good agreement with theoretical expectations and the first three levels were interpreted as the $p_{\frac{1}{2}}$, $f_{\frac{5}{2}}$, and $p_{\frac{3}{2}}$ quasiparticle states. (auth) (Sweden)

13989 POSITIVE-PARITY STATES IN ^{77}Br. Holm, G.; Astner, G.; Borg, S.; Persson, A. (Research Inst. for Physics, Stockholm). Ark. Fys., 34: 401-11(1967).

The decay of ^{77}Kr leading to states in ^{77}Br were investigated. Multipolarities for strong transitions were determined, and the lifetime of the 130-keV level was measured to be 9.3 ± 0.3 nsec. A ^{77}Br level scheme was constructed with levels at $0(\frac{3}{2}^-)$, 106 $(\frac{5}{2}^+)$, 130$(\frac{5}{2}^+)$, and 276$(\frac{3}{2}^+$ or $\frac{5}{2}^+)$keV. The deviations from what is qualitatively expected from a model with quasiparticle and phonon excitations are discussed. (auth) (Sweden)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 12338, 13226, 13933, 13966, 13969, 13974, 13985, 13986, 14074, 14075, 14080, 14081, 14095, 14108, and 14113.

13990 (GEMP-579) ^{235}U FISSION PRODUCT DECAY ENERGY RELEASE RATES. Brunner, J. M.; Edwards, W. E. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Section). Dec. 1967. Contract AT(40-1)-2847. 29p. Dep.

Recent calculated and measured data were used to prepare revised graphs of fission product decay gamma energy release rate as a function of time between 1 and 10^9 seconds following instantaneous thermal ^{235}U fission and reactor operation from 1 minute to 1000 hours. Empirical expressions for fission product decay beta energy release rate were confirmed by recent measured data and were evaluated for the same operating and shutdown histories considered in the gamma analysis. Beta energy release rates, gamma energy release rates for seven energy groups, total gamma energy release rates, and the sum of the beta and gamma energy release rates are all presented graphically as a function of time after reactor shutdown. The total fission product energy release rates were reported previously in AFRPL-TR-65-196. The individual group data following reactor shutdown are included for use in detailed shutdown reactor-shield analyses. The release rates following instantaneous fission are included so that data may be generated for other reactor operating and shutdown histories as needed. (auth)

13991 (IAE-1389) OB ODNOI VOZMOZHNOSTI PROVERKI KVAZISTATICHESKOGO KHARAKTERA DELENIYA YADER. (A Possible Method of Testing the Quasi-Statistical Character of Nuclear Fission). Shigin, V. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1967. 8p. (In Russian). Dep.

The results of a calculation of the mass distribution from ^{252}Cf at excitation energies of 6 and 21 MeV on the basis of the statistical approach to fission are reported. In contrast to the adiabatic approach, the statistical approach predicts for this nucleus a decrease of the mass yield in the area of symmetric fission with an increase of the excitation energy. Experiments with ^{252}Cf make it possible to establish which of these approaches appears to be accurate and also to explain whether fission appears at low excitation energies with the quasi-statistical processes. (tr-auth)

13992 (IIAE-LR-18) NON-ADIABATICITY OF BETA VIBRATIONS IN THE DAVYDOV MODEL. Plastino, A.; Abecasis, S. M.; Bosch, H. E. (Istituto de Investigacion Aeronautica y Espacial, Buenos Aires (Argentina)). July 1967. 7p.

The feasibility of an adiabatic treatment of beta vibrations for even-even rare-earth nuclei is investigated with the restricted formula of Davydov. The parameters γ and μ as deduced from the fitting of experimental data with Davydov-Chaban predictions are used as zero-order approximation. For all the nuclei considered, at a certain stage of the iterative process, the parameters got out of the range of validity of the restricted formula. Taking into account the values of those parameters for other regions of the periodic table, the conclusion can be drawn that an adiabatic treatment of beta vibrations within the frame of the Davydov model can not be made. (auth)

13993 (IIAE-LR-19) E2 TRANSITION PROBABILITIES IN THE DAVYDOV MODEL. Abecasis, S. M.; Bosch, H. E.; Plastino, A. (Instituto de Investigacion Aeronautica y Espacial, Buenos Aires (Argentina)). Aug. 1967. 10p.

Ratios of E2 transition probabilities for the de-excitation of levels belonging to the ground-state, beta, and gamma rotational bands in the deformed region $150 < A < 190$ are calculated using the Davydov model. A general good agreement with experiment is obtained. (auth)

13994 (JINR-P4-3611) MAGNITNYE MOMENTY KOLLEKTIVNYKH SOSTOYANII CHETNO-CHETNYKH SFERI-

CHESKIKH YADER. (Magnetic Moments of the Collective States of Even–Even Spherical Nuclei). Bal'butsev, E. B.; Dzholos, R. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 13p. (In Russian). Dep.

Magnetic moments of the first 2^+ states of even Ru, Pd, Cd, and Te isotopes are analyzed on the basis of a model that takes into account pairing and quadrupole forces. It is shown that the theoretical results can agree with the experimental data. It means that the wave functions of the first 2^+ states are determined, on the whole, by collective quadrupole motion in the nucleus. (auth)

13995 (JINR–P6-3634) RASPAD ^{159}Ho. (The Decay of ^{159}Ho). Abdurazakov, A. A.; Zhelev, Zh., Kalinnikov, V. G.; Liptak, J.; Molnar, F.; Nazarov, U. K.; Urbanec, J. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 21p. (In Russian). Dep.

The γ-ray and conversion spectra emitted at the decay of ^{159}Ho were investigated. New γ transitions with the energies 302.6, 336.0, 408.4, 460, 566.8, 588.9, 712, and 797 keV were observed. The multipolarities of the most ^{159}Ho γ transitions were determined. On the basis of the data obtained, a scheme of the ^{159}Dy excited levels is proposed. (auth)

13996 (JINR–P7-3617) DELENIE KAK METOD SINTEZA IZOTOPOV. (Fission as a Method of Isotope Synthesis). Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 16p. (In Russian). Dep.

Perspectives of the synthesis of new isotopes are considered. Various methods of production of new isotopes such as fusion reactions, transfer reactions, and nuclear fission are considered. A possible synthesis of distant transuranium elements is discussed. (auth)

13997 (JINR-P15-3618) ANALIZ REAKTSII ^{241}Am(n,γ)^{242mf}Am. (Analysis of the Reaction ^{241}Am(n,γ)^{242mf}Am). Yungklaussen, Kh.; Pleve, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 12p. (In Russian). Dep.

An attempt is made to explain experimentally obtained excitation functions of the radiative capture of fast neutrons by the ^{241}Am nucleus, which leads to the production of spontaneously fissionable ^{242mf}Am isomer. It is assumed that the dependence of the potential energy on the value of β deformation has two maxima; the isomeric state is in the second potential well between two maxima. The calculated excitation function agrees well with the experimental one, if the second maximum is considered to be somewhat lower than the first maximum. (auth)

13998 (NP–17212) ETUDE DES NIVEAUX EXCITES DU GADOLINIUM 155 OBTENUS A PARTIR DE L'EUROPIUM 155. (Study of Excited Levels of ^{155}Gd Obtained from ^{155}Eu). Foin, Claude (Grenoble Univ. (France). Faculte des Sciences). Dec. 5, 1966. 45p. (In French). Dep.

Thesis.

The experimental techniques used for the study of the excited levels of ^{156}Gd are outlined. The experimental results are discussed at length. The internal conversion spectrum obtained with a high-resolution spectrometer made it possible to determine with precision the relative intensities of different conversion-electron rays and to deduce the multipolar order of the majority of the transitions. The measurements are in good agreement with the theoretical values of Sliv and with the measurements of Harmatz. The study of the spectra with a Ge junction made it possible to give an order of magnitude of the intensity of the 146-keV photon which was observed only by Coulomb excitation. The external conversion spectra gave with good precision the relative intensities of the different photons. From different measurements, the spin $I = 5/2$ and its projection $K = 5/2$ for the level at 105.3 keV were deduced. An absolute determination was made of the α_K coefficients of the 86.5- and 105.3-keV transitions. (J.S.R.)

13999 (NP–17219) CONTRIBUTION A L'ETUDE DU SCHEMA DE DESINTEGRATION DU ^{183}Hf. (Contribution to Study of Decay Scheme of ^{183}Hf). Motevalledi Nobar, Youssef (Grenoble Univ. (France). Faculte des Sciences). [1966]. 70p. (In French). Dep.

Thesis.

The reaction ^{186}W(n,α)^{183}Hf was used in the study of the decay scheme of ^{183}Hf. A chromatographic separation developed in the laboratory of nuclear chemistry at Grenoble made it possible to eliminate to a great extent isotopes other than ^{183}Hf formed by (n,p), (n,α), and (n,2n) reactions. The methods used for the preparation of the sources are outlined. The γ and β spectrometric methods used for the identification and determination are described in detail. Direct γ spectrometry, γ-γ coincidence spectrometry, and β spectrometry were used. On the basis of the results obtained, a partial decay scheme of ^{183}Hf is presented. (J.S.R.)

14000 (NP–17225) ANALYSE DE GROUPES D'ELECTRONS DE CONVERSION INTERNE. (Analysis of Internal Conversion Electron Groups). Traore, Harouna (Grenoble Univ. (France). Faculte des Sciences). [1966]. 24p. (In French). Dep.

Thesis.

The β spectrometer and techniques used for the analysis of the internal conversion electrons of ^{231}Th and ^{155}Eu are described in detail. The sources used made it possible to record the L- and M-conversion electrons of the 58.5-keV transition of ^{231}Th. The results showed that the transition can be considered as pure E2. As the number of M-conversion electrons was very low, no conclusions could be made as to the nature of the transition. The study of the ^{155}Eu internal conversion electrons confirmed the nature of the 86.5- and 59.95-keV transitions previously obtained. A L_I ray of a weak transition at 85.9 keV and an M group at 59.95 keV were detected. (J.S.R.)

14001 (RPI–328-100, pp 1-56) NEUTRON CROSS SECTIONS. (Rensselaer Polytechnic Inst., Troy, N. Y.).

Capture data for Al, Fe, Ni, and Na up to 200 keV were converted to capture yields; resonance parameters were determined for many resonances in these elements. The number of neutrons emitted in the fission of ^{235}U was measured for neutron energies of 0.012 to 2.0 eV. Simultaneous measurements of the capture and fission cross sections of ^{233}U were performed in the neutron energy range from 0.4 to 1000 eV; resonance integrals were obtained. The neutron total cross section of ^{147}Pm was measured in a transmission experiment; resonance parameters for resonances at 5.36, 6.57, and 6.92 eV were obtained by shape analysis. The development of a spark chamber for detecting ^{233}U fission fragments continued. (D.C.W.)

14002 (UUIP–555) THE DECAY OF ^{90}Nb. Pettersson, H.; Antman, S.; Grunditz, Y. (Uppsala Univ. (Sweden). Inst. of Physics). Sept. 1967. 33p. Dep.

The decay of 14.60 ± 0.05-hr ^{90}Nb was investigated with a double-focusing iron-yoke spectrometer and with a Ge(Li) detector. The end-point energy of the intense (53 ± 6%) positron branch was determined to be (1500 ± 4) keV, leading to a Q-value of 6111 ± 5 keV. 17 transitions were found in the internal conversion spectrum, and among these 6 are not previously reported at 518, 828, 1575, 1717, 1914, and 2223 keV. The K-conversion coefficients were determined by combining the internal conversion intensities with the gamma-ray intensities. For many transitions, probable multipolarity assignments were obtained from these coefficients and also from $K/\Sigma L$ and $L_I/L_{II} + L_{III}$ ratios. The M-conversion intensities of the 133- and 141-keV transitions were found to be in agreement with the recent tabulations of Hager and Seltzer. All transitions observed were fitted into a tentative decay scheme, which in its lower part is in agreement with the recent tabulations of Hager and Seltzer. All transitions observed were fitted into a tentative decay scheme, which in its lower part is in agreement with shell-model calculations. (auth) (Sweden)

14003 (BNL-tr–174) NEUTRON CAPTURE IN HEAVY URANIUM AND NEPTUNIUM ISOTOPES UNDER THERMONUCLEAR EXPLOSION CONDITIONS. Zagrafov, V. G.; Zommer, V. P. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from At. Energ. (USSR), 23: 319-26(1967). 21p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

Cross sections for neutron radiative capture by Np and U isotopes were calculated using a formalism that takes into account the approximate effect of shells on the level density in the Fermi-gas model. A theoretical description of the yield of heavy isotopes from multiple neutron capture in thermonuclear explosions was formulated, and a diagram technique was developed to permit comparison of experimental yield curves with theoretical curves obtained using the calculated cross sections. It was found that the calculated cross sections give a good account of the experimental dependence of the capture cross section on the parity and mass number of the isotope, at least in the range $250 \lesssim A \lesssim 257$. It was also noted that the capture cross sections as a function of mass number should exhibit a dip in the range $165 + Z \lesssim A \lesssim 168 + Z$ of the mass numbers of the target material. (D.C.W.)

14004 (BNL-tr–175) CROSS SECTIONS AND RESONANCE CAPTURE AND FISSION INTEGRALS OF LONG-LIVED AMERICIUM ISOTOPES. Bak, M. A.; Krivokhatskii, A. S.; Petrzhak, K. A.; Petrov, Yu. G.; Romanov, Yu. F.; Shlyamin, E. A. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from At. Energ. (USSR), 23: 316-19(1967). 12p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Samples of pure ^{241}Am and of a mixture of ^{241}Am and ^{243}Am were irradiated in the VVR-M reactor; and the formation of ^{242}Am, ^{242m}Am, and ^{244}Am was studied. Cadmium ratios were determined, and the α activity of the products formed was measured using silicon detectors. Values for the neutron capture and fission cross sections and resonance integrals of ^{241}Am, the fission cross sec-

tion and resonance integral of ^{242}Am, and the capture cross section and resonance integral of ^{243}Am were obtained. (D.C.W.)

14005 DECAY OF 2-YEAR ^{102}Rh. Adachi, M.; Taketani, H.; Hisatake, K. (Tokyo Inst. of Tech.). J. Phys. Soc. Jap., 24: 227-35(Feb. 1967).

The singles and coincidence spectra of gamma rays from the decay of 2-yr ^{102}Rh were measured with a Ge(Li) detector and scintillation spectrometers. The energies (in keV) of the gamma rays observed are 418.5, 475.2, 632.0, 698.1, 768.3, 1046.9, 1111.7, and 1786. With measurements of internal conversion electrons and gamma-gamma directional correlations for several sets of cascade transitions, the following spin-parity assignments were made for levels in ^{102}Ru: 475.2(2+), 1103(2+ and 4+ doublet), 1522(3+), 1870(5+ or 6+), 2222(5+), and 2261(?). The spin and parity of 2-yr ^{102}Rh are probably 6+. (auth)

14006 BETA AND GAMMA SPECTROSCOPIC STUDIES OF ^{125}Sb. Inamura, Takashi (Tokyo Inst. of Tech.). J. Phys. Soc. Jap., 24: 1-16(Jan. 1968).

The decay of ^{125}Sb was investigated by using a Ge(Li) detector and NaI(Tl) and plastic scintillators. The decay scheme proposed by Mazets and Sergeenkov was confirmed. By combining the Ge(Li) data and internal-conversion data, the K-conversion coefficients of all the gamma rays observed were deduced. Multipolarities of the 111.0-, 172.0-, 204.3-, 208.9-, 320.9-, and 379.5-keV transitions were determined by the analysis of the remeasured gamma-gamma directional correlations. The 320.9-, 117.3-, and 111.0-keV transitions were found to have predominantly E1 contents that are j-forbidden in the j-j coupling scheme. The 444-keV beta−176.7-keV gamma delayed coincidences were measured, and the half-life of the 321.1-keV state (9/2$^-$) was found to be $8.7 \pm 0.8 \times 10^{-10}$ sec. This implies that the 321.1-keV state has a significantly enhanced E2 transition moment. The experimental results obtained are compared with the theoretical predictions based on the pairing-plus-quadrupole force, the particle-plus-phonon, and the rational models. (auth)

14007 DETERMINATION OF Y_{40} AND Y_{60} COMPONENTS IN THE SHAPES OF RARE EARTH NUCLEI. Hendrie, D. L.; Glendenning, N. K.; Harvey, B. G.; Jarvis, O. N.; Duhm, H. H.; Saudinos, J.; Mahoney, J. (Univ. of California, Berkeley). Contract W-7405-Eng-48. Phys. Lett., 26B: 127-30(Jan. 8, 1968). (UCRL-17890).

Differential cross sections for 50-MeV alpha particles of members of the ground-state rotational band up to the 6$^+$ or 8$^+$ state were measured in a number of even nuclei of the rare-earth region. The data were analyzed under the assumption of a perfect rotor description for the nucleus and a deformed optical interaction between alpha and nucleus by solving the resulting coupled equations. Higher-order components Y_4 and Y_6 in the nuclear shapes were determined with precision. A systematic variation of B_4 from positive values in the light rare earths to negative values in the heavy rare earths is established. (auth)

14008 A DETERMINATION OF THE GYROMAGNETIC RATIOS OF ^{161}Dy FROM BRANCHING-RATIO MEASUREMENTS. Hagemann, G. B.; Tveter, A. (Univ. of Copenhagen). Phys. Lett., 26B: 136-7(Jan. 8, 1968).

The ground-state band up to spin $^{13}/_2$ of ^{161}Dy was studied by Coulomb excitation with 46-MeV oxygen ions. Gamma rays from thin ^{161}Dy isotope separated targets (0.1 mg/cm^2) were observed in coincidence with backscattered ions. From the observed branching ratios $g_R = 0.11 \pm 0.02$ and $g_K = -0.30 \pm 0.02$ were derived for the gyromagnetic ratios. (auth)

14009 FISSION PRODUCT YIELDS FROM 1.5- AND 3.0-GeV ELECTRONS ON URANIUM. Williams, I. R. (Oak Ridge National Lab., Tenn.); Fulmer, C. B.; Dell, G. F.; Engebretson, M. J. Phys. Lett., 26B: 140-2(Jan. 8, 1968). (ORNL-P-3579).

Yields of fission products of natural uranium irradiated with 1.5- and 3.0-GeV electron beams were measured with a Ge(Li) gamma-ray spectrometer. The mass yields exhibit two broad peaks with a shallow valley in the symmetric fission region. (auth)

14010 NUCLEAR SPINS OF ^{169}Lu, ^{170}Lu, ^{171}Lu, ^{165}Tm, AND ^{160}Er. Ekstrom, C.; Lindgren, I.; Nyqvist, H.; Rosen, A.; Adelroth, K. E. (Chalmers Univ. of Tech., Gothenburg, Sweden). Phys. Lett., 26B: 146-7(Jan. 8, 1968).

The ground-state spins of the following neutron-deficient nuclei were measured by the atomic beam magnetic-resonance method: ^{169}Lu(I = $^1/_2$), ^{170}Lu (I = 0), ^{171}Lu (I = $^1/_2$), ^{165}Tm (I = $^1/_2$), and ^{160}Er (I = 0). (auth)

14011 CHARGE EXCHANGE EFFECTS IN THE (d,p) REACTION LEADING TO STATES IN ^{93,95}Zr, ^{93,95}Mo, AND ^{141}Ce. Heffner, R.; Ling, C.; Cue, N.; Richard, P. (Univ. of Washington, Seattle). Phys. Lett., 26B: 150-2(Jan. 8, 1968).

Excitation functions for the (d,p) reaction leading to the first few levels in ^{93,95}Zr, ^{93,95}Mo, and ^{141}Ce were obtained in the region of the (d,n) thresholds to the corresponding isobaric analog states. Anomalies were observed in the reactions leading to the $d_{5/2}$ ground state in ^{93,95}Zr and ^{93,95}Mo and the $s_{1/2}$ first excited state in ^{95}Zr at the corresponding (d,n) thresholds. (auth)

14012 SINGLE-PARTICLE STRENGTH IN THE COLLECTIVE MULTIPLET AT 2.6 MeV IN ^{209}Bi. Ellegaard, C.; Vedelsby, P. (Univ. of Copenhagen). Phys. Lett., 26B: 155-7(Jan. 8, 1968).

The distribution of single-proton strength in ^{209}Bi was studied by means of the reaction ^{208}Pb(^{3}He,d)^{209}Bi. The $^{13}/_2$ state in the multiplet at 2.6 MeV arising from the coupling of the $h_{9/2}$ ground-state proton to the 3$^-$ state of ^{208}Pb is populated and a spectroscopic factor of 0.06 is found. Seven other levels are strongly populated. Of these, six are consistent with shell-model predictions and earlier assignments. The presence of the extra peak is probably due to a particle-vibration coupling similar to the one associated with the $^{13}/_2$ state. (auth)

14013 MOESSBAUER EFFECT AND LIFETIME OF THE 46.5 keV LEVEL OF ^{183}W. Drosg, M.; Ujlaki, E. (Technische Hochschule, Vienna). Contract 61(052)-845. Acta Phys. Austr., 25: 334-5(Dec. 1967).

The Moessbauer factor for Ta is determined (f_{Ta}(295°K) = 0.13) using a crystal spectrometer for background elimination. The half-life of the level is found to be 0.19 ± 0.02 nanosec. (auth)

14014 THE MAGNETIC MOMENT OF THE FIRST EXCITED 2$^+$ STATE OF ^{152}Sm. Atzmony, U.; Bauminger, E. R.; Froindlich, D.; Ofer, S. (Hebrew Univ., Jerusalem). Phys. Lett., 26B: 81-2(Dec. 25, 1967).

The magnetic moment of the 122 keV, 2$^+$ rotational state of ^{152}Sm was measured using the Mossbauer effect in samarium iron garnet and was found to be $\mu = (0.832 \pm 0.050)\ \mu_N$. (auth)

14015 ESTABLISHMENT OF AN EXCITED STATE AT 1.64 keV IN ^{193}Pt. Johansson, A.; Malmsten, G.; Marelius, A.; Nyman, B.; Pettersson, H.; Svahn, B. (Univ. of Uppsala). Phys. Lett., 26B: 83-4(Dec. 25, 1967).

A nuclear energy level of 1.64 keV in ^{193}Pt was established in a high-resolution study of the internal conversion spectrum in the ^{193}Au decay. The measured half-life is 9.7 ± 0.6 ns and the de-exciting transition is most probably of M1 character. (auth)

14016 SPONTANEOUS FISSION OF LIGHT FERMIUM ISOTOPES; NEW NUCLIDES ^{244}Fm AND ^{245}Fm. Nurmia, M.; Sikkeland, T.; Silva, R.; Ghiorso, A. (Univ. of California, Berkeley). Phys. Lett., 26B: 78-80(Dec. 25, 1967). (UCRL-17891).

The spontaneous fission half-lives of ^{245}Fm and ^{248}Fm were determined. The new nuclides ^{244}Fm and ^{245}Fm were identified and their decay studied. (auth)

14017 THE ENERGY GAP IN ^{110}Pd ACCORDING TO THE HARTREE-FOCK AND THE HARTREE-FOCK-BOGOLYUBOV APPROACHES. Faessler, A. (Univ., Munich); Sauer, P. U.; Stingl, M. M. Phys. Lett., 26B: 71-4(Dec. 25, 1967).

The energy gap in the single particle spectrum is due to the pairing part of the nucleon-nucleon interaction and to the Hartree-Fock self-consistency. Both degrees of freedom are treated on the same footing by the Hartree-Fock-Bogolyubov theory in the nucleus ^{110}Pd. One finds that even in this medium heavy nucleus the energy gap is mainly due to the HF self-consistency. The ground state correlation energy is reduced by this effect from 5 MeV (Kisslinger and Sorenson) to 260 keV. One also finds a qualitative explanation for the quadrupole moment of the first 2$^+$ state (reorientation effect). (auth)

14018 MEASUREMENTS OF THE DECAY OF ^{145}Sm BY Ge/Li/GAMMA-SPECTROMETER. Uchrin, Janos; Varga, Dezso; Szalay, Sandor; Berenyi, Denes; Molnar, Ferenc. ATOMKI (At. Kut. Intez.) Kozlem., 9: 261-4(Oct. 1967). (In Hungarian).

Gamma-rays in the decay of ^{145}Sm were investigated by a Ge/Li/gamma-spectrometer in a low background chamber of limestone. Beyond the well-known lines of 61.2 and 492.5 keV four new lines were found with energies 117.4, 153.2, 165.5, and 549.8 keV. Relative intensities of the new lines are given and a new possible decay scheme is proposed. (auth)

14019 ELASTIC SCATTERING OF POLARIZED NEUTRONS WITH ENERGY 4 MeV ON THE NUCLEI ^{9}Be, ^{12}C, ^{59}Co, ^{62}Ni, ^{80}Se, ^{93}Nb, ^{114}Cd, ^{115}In, ^{118}Sn, ^{127}I, Pb, AND ^{209}Bi. Gorlov, G. V.; Lebedeva, N. S.; Morozov, V. M. Yadern. Fiz., 6: 910-18 (Nov. 1967). (In Russian).

Elastic scattering of the 4-MeV polarized neutrons from the D(d,n)^{3}He reaction at the angles from 10 to 170° on the nuclei ^{9}Be, ^{12}C, ^{59}Co, ^{62}Ni, ^{80}Se, ^{93}Nb, ^{114}Cd, ^{115}In, ^{118}Sn, ^{127}I, Pb, and ^{209}Bi was studied. The scattering asymmetry, differential cross sections for unpolarized neutrons, elastic scattering cross sections, and inelastic interaction cross sections are determined from the experimental values of the differential and total cross sections. Unified parameters of the optical potential are chosen. (auth)

14020 SPECTRA OF ODD–ODD NUCLEI. Osadchiev, V. M.; Troitskii, M. A. Yadern. Fiz., 6: 961-8(Nov. 1967). (In Russian).

It is shown that the spectra of the odd-odd nuclei with large angular momenta differ from the shell-model spectra by the matrix element of the static amplitude of interaction. The results of calculation are given for spectra of ^{208}Bi, ^{208}Tl, and ^{40}K. (auth)

14021 ^{111}Te-DELAYED PROTON EMITTER. Bogdanov, D. D.; Darotsi, Sh.; Karnaukhov, V. A.; Petrov, L. A.; Ter-Akop'yan, G. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 893-900(Nov. 1967). (In Russian).

The delayed proton emitter with $T_{\frac{1}{2}}$ = 19.5 sec in the reaction ^{102}Pd + ^{12}C was investigated. It was found from the excitation function that it is ^{111}Te. Due to the high density of levels of Sb daughter nuclei, the proton spectrum has complex structure. The averaged form of the proton spectrum was analyzed. The calculated form of the spectrum is in the best agreement with the experiment assuming that the averaged square of the matrix element of β transition exponentially decreases with the increase of excitation energy of the daughter nucleus. (auth)

14022 ON MULTIPOLARITY OF THE 661.59-keV TRANSITION IN ^{137}Ba. Kartashov, V. M.; Stakhov, O. V.; Troitskaya, A. G.; Shevelev, G. A. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 6: 901-5(Nov. 1967). (In Russian).

The experimental ratios of the conversion electron intensities K/L and $L_I : L_{II} : L_{III}$ are compared with the theoretical quantities for the 661.59-keV transition in ^{137}Ba. The possibility to ascribe this transition to the multipole mixture 71 ± 2% M4 + 29 ± 2% E5 is discussed. It is noted that there is some discrepancy between the experimental quantity and the calculated value of the K-shell inner conversion coefficient for the given multipolarity of the transition. (auth)

14023 LONG-RANGE PARTICLES IN FISSION OF ^{235}U INDUCED BY 14-MeV NEUTRONS. Adamov, V. M.; Kovalenko, S. S.; Petrzhak, K. A.; Tyutyugin, I. I. Yadern. Fiz., 6: 930-4(Nov. 1967). (In Russian).

Fractional yields of protons, tritons, and α particles in fission of ^{235}U by slow neutrons and by 14-MeV neutrons were determined. The fragments were registered by the ionization chamber, and the light particles were registered by the CsI(Tl) crystal. The discrimination between protons, tritons, and α particles was carried out by analyzing the luminescence time of the CsI(Tl) crystal. At the slow neutron fission, 2.8 ± 0.5 protons and 8 ± 1 tritons were emitted per 100 α particles; and at the fission by 14-MeV neutrons, 4 ± 2 protons and 11 ± 2 tritons were emitted per 100 α particles. The probabilities of the triple fissions by fast and slow neutrons relate as $W_{En = 14\ MeV}/W_{slow}$ equal to 0.99 ± 0.04. The energy distributions for α particles and tritons do not depend within the experimental errors on the energy of the incident neutrons. (auth)

14024 DOUBLE CHARGE EXCHANGE OF π MESONS ON NUCLEI IN PHOTOEMULSION. Batusov, Yu. A.; Bunyatov, S. A.; Sidorov, V. M.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 998-1007(Nov. 1967). (In Russian).

Total cross sections of the double charge exchange of π^+ and π^- mesons in the energy region 40 to 176 MeV are measured. Energy and angular distributions of secondary π mesons are given. The prong distribution of stars accompanying these processes in the photoemulsion are discussed. Experimental results are compared with the cascade model calculations. (auth)

14025 MEASUREMENT OF THE TENSOR POLARIZATION DEGREE OF THE POLARIZED DEUTRON BEAMS. Slabospitskii, R. P.; Andreev, G. B.; Taranov, A. Ya.; Deineko, A. S.; Kiselev, I. E.; Lopatko, I. D. Yadern. Fiz., 6: 992-4(Nov. 1967). (In Russian).

A polarized ion beam was accelerated by a charge-exchange accelerator. The intensity of the polarized deuteron beam at the target of the scattering chamber with the input diaphragm of 3-mm diameter was 10^9 part/sec. The degree of tensor polarization (P_{33}) was determined by investigating the asymmetry of the proton angular distribution from the reaction ^{3}He(d,p)^{4}He. The measured value $P_{33} = -0.290 \pm 0.017$ is in good agreement with the calculated data. (auth)

14026 STATISTICAL ESTIMATION OF THERMAL-NEUTRON CROSS SECTIONS. Cook, J. L.; Wall, A. L. (Australian Atomic Energy Commission Research Establishment, Sutherland, New South Wales). Nucl. Sci. Eng., 31: 234-40(1968).

The thermal radiative capture cross sections of 87 nuclides were computed using a Monte Carlo selection of reduced neutron widths, and the assumption that distant resonance levels determine the cross section. Histograms of possible cross-section values were prepared for each nuclide, and the 87 samples were analyzed to find the overall accuracy of estimation. The results indicated a fluctuation of 0.4 ± 0.6 for the logarithm of the ratio of experiment to the calculated mean cross section. Tables of results for means and standard deviations are given together with the results of Keane's summation formula. The possible use of this technique in estimating unknown cross sections is discussed. (auth)

14027 THE DOPPLER EFFECT ON THE ^{238}U(n,γ) REACTION AT DIFFERENT NEUTRON ENERGIES AND AT HIGH TEMPERATURES. Fieldhouse, P.; Perkin, J. L.; Warner, G. P.; Brickstock, A.; Davies, A. R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Nucl. Energy, 21: 847-55(Nov. 1967).

Measurements of the Doppler effect on the ^{238}U(n,γ) reaction were made on uranium metal samples, heated to 770°K, with neutrons of different energies in the range 0 to 54 keV from the ^{7}Li(p,n) reaction. The measurements made in one particular energy range (0 to 10 keV) were extended to temperatures up to 1960°K using uranium dioxide samples. The results obtained were compared with computer calculations. In the uranium metal samples the Doppler effect at different neutron energies was found to agree, within the rather large experimental errors, with the theoretical calculations. In the uranium oxide samples the measured Doppler effect over the temperature range 290 to 1960°K agreed with that calculated, except for the first 200°K of this range where the measured effect was greater than that calculated. (auth) (UK)

14028 THE HALF-LIVES OF ^{166}Ho, ^{167}Tm, AND ^{168}Tm AND THE ^{165}Ho(n,γ)^{166m}Ho CROSS SECTION. Nethaway, D. R.; Missimer, M. C. (Univ. of California, Livermore). J. Inorg. Nucl. Chem., 30: 15-18(Jan. 1968).

The decay of several samples of ^{167}Tm and ^{168}Tm was followed for a period of two years. The half-lives were measured as 9.24 ± 0.02 days (^{167}Tm) and 93.1 ± 0.1 days (^{168}Tm). These results are in agreement with those reported previously, but differ considerably from the currently accepted values. The cross section for the ^{165}Ho(n,γ)^{166m}Ho reaction with thermal neutrons was measured as 3.4 ± 0.5 barn. The half-life of ^{166}Ho was also remeasured and found to be 26.79 ± 0.03 hr. (auth) (UK)

14029 PROMPT $\bar{\nu}$ IN NEUTRON-INDUCED FISSION OF ^{239}Pu AND ^{241}Pu. Conde, H.; Hansen, J.; Holmberg, M. (Research Inst. of National Defence, Stockholm). J. Nucl. Energy, 22: 53-60 (Jan. 1968).

The energy dependence of prompt $\bar{\nu}$ was investigated for the neutron-induced fissions of ^{239}Pu and ^{241}Pu. The fission neutron detector was a large liquid scintillator, and $\bar{\nu}$ for the spontaneous fission of ^{252}Cf was used as a standard. The measurements of ^{239}Pu and ^{241}Pu were made at incident neutron energies between 4 and 14.8 MeV and 0.5 and 14.8 MeV, respectively. The best fit of the present data for ^{239}Pu and ^{241}Pu are the lines $\bar{\nu}(E_n) = 2.91 + 0.141E_n$ and $\bar{\nu}(E_n) = 2.91 + 0.146E_n$ based on $\bar{\nu} = 3.764$ for ^{252}Cf. (auth) (UK)

14030 THE HALF-LIFE OF ^{231}Pa. Brown, D.; Dixon, S. N.; Glover, K. M.; Rogers, F. J. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 30: 19-22(Jan. 1968).

The half-life of ^{231}Pa was determined by a combination of total α-assay and α-pulse analysis using solutions prepared by dissolution of various Pa penta- and tetrahalides in concentrated nitric acid. The specific activity of the ^{231}Pa was found to be 1.062 ± 0.0076 α dmin^{-1}mg^{-1}, equivalent to a half-life of 32,340 ± 230 years. (auth) (UK)

14031 TRANSITIONS FOLLOWING THE DECAYS OF (86 MIN) ^{197m}Pt AND (18 h) ^{197}Pt. Bashandy, E.; Migahed, M. (Atomic Energy Establishment, Cairo). Ann. Phys. (Leipzig), (7), 20: 152-61(1967).

The internal-conversion electron spectrum of transitions in the decays of (86 min) ^{197m}Pt and (18 h) ^{197}Pt was studied by means of an iron-free, double-focusing beta spectrometer. Conversion electrons were observed for transitions of 268.2 ± 0.2 and 269.1 ± 0.2 keV, the first ascribed to the decay of (18 h) ^{197}Pt and the second ascribed to the decay of (86 min) ^{197m}Pt. An energy level in ^{197}Au at 548 keV was also observed for the first time from the decay of ^{197m}Pt, de-excited by the 269–279-keV cascade and

a direct 548.4 ± 0.4-keV transition to the ground state. A new gamma transition of energy 202.5 ± 0.1 keV was found which decays from the 279-keV excited level in ^{197}Au, with an E2 character. The internal K-conversion coefficients of most transitions in ^{197}Pt and ^{197}Au were determined by the internal–external conversion method. The K-internal conversion coefficient of the 191 keV transition in ^{197}Au indicated no E0 contribution. Multipolarity data, obtained from the absolute or ratios measurements of conversion coefficients, were utilized for assigning possible spins and parities to the levels in ^{197}Pt and ^{197}Au. (auth)

14032 RELATIVE MEASUREMENT OF THE LONGITUDINAL POLARIZATION OF THE β-RAYS FROM ^{152}Eu DECAY. Wallek, L. (Univ., Muenster, Ger.). Z. Phys., 209: 409-18(1968). (In German).

The longitudinal polarization P of the β rays from the 1.49-MeV transition of ^{152}Eu (T = 13 yr) was measured relative to ^{32}P using the Møller-scattering method (electron-electron-scattering). Taking the polarization of ^{32}P as $P(^{32}P) = -(v/c)$, $P(^{152}Eu) = -(0.959 \pm 0.028)\ (v/c)$ is obtained at a mean energy of 1100 keV. This result is in good agreement with the set of matrix elements taken from measurements of other observables. (auth)

14033 TIME INVARIANCE OF THE ELEMENTARY CHARGE. Gold, Raymond (Argonne National Lab., Ill.). Phys. Rev. Lett., 20: 219-20(Jan. 29, 1968).

Two independent measurements of the spontaneous fission decay constant of ^{238}U that imply time-independence of the decay constants for at least two eons are discussed. This experimental evidence is consistent with a time-independent elementary charge. An upper limit on the variation of the elementary charge within the last two eons is proposed. (D.C.W.)

14034 SEARCH FOR A CONSERVED-VECTOR-CURRENT MECHANISM IN THE EMISSION OF PROTONS FROM μ^- STARS IN EMULSION. Kotelchuck, D.; Tyler, James V. (Vanderbilt Univ., Nashville). Phys. Rev., 165: 1190-4(Jan. 20, 1968).

The energy spectrum of protons from 1289 single-prong μ^- stars in emulsion was studied, with special attention given to the energy region above 20 MeV. In this energy region, Bertero, Passatore, and Viano had predicted an enhanced proton emission as a result of muon interaction with pion currents in the nucleus according to the theory of conserved vector current (CVC). No evidence of the predicted 25-MeV peak in the CVC spectrum was found, nor was there any evidence of a high-energy tail to the spectrum which was predicted to extend up to 90 MeV. The results are quite consistent with Singer's earlier theory. If the CVC mechanism occurs here at all, it occurs at least a factor $2.0 \pm 1.0 \times 10^{-2}$ less frequently than predicted. (auth)

14035 NUCLEAR REACTIONS OF SILVER AND INDIUM WITH 200- AND 400-MeV PROTONS. Panontin, J. A. (Purdue Univ., Lafayette, Ind. Carnegie Inst. of Tech., Pittsburgh); Porile, N. T.; Caretto, A. A. Jr. Phys. Rev., 165: 1273-81(Jan. 20, 1968).

The cross sections of a number of (p,ypxn) reactions (y = 0 – 4, x = 3 – 12) of silver and indium with 200- and 400-MeV protons were determined. The results are compared with calculations based on the Vegas and Metropolis cascade codes and a Monte Carlo evaporation calculation. Poor agreement is obtained with respect to both the magnitude of the cross sections and the ratios of isobaric yields. Several possible sources of these discrepancies are discussed. (auth)

14036 RECOIL PROPERTIES OF PRODUCTS FROM THE SPALLATION OF SILVER AND INDIUM. Panontin, J. A. (Purdue Univ., Lafayette, Ind. Carnegie Inst. of Tech., Pittsburgh); Porile, N. T.; Caretto, A. A. Jr. Phys. Rev., 165: 1281-6(Jan. 20, 1968).

Average projected recoil ranges in the forward, backward, and perpendicular direction to the beam were measured for a number of palladium and silver products formed in the interaction of silver and indium with 200- and 400-MeV protons. The values of the forward and perpendicular ranges increase with the mass differences between target and product and the dependence becomes exponential for $\Delta A > 7$. The results were compared with a Monte Carlo cascade-evaporation calculation based on the Vegas cascade code. The calculation included a correction for scattering effects. It is found that the calculated values are in moderately good agreement with the measured values of the forward and perpendicular ranges, but underestimate the values of the backward range. (auth)

14037 HIGH-RESOLUTION STUDIES OF (d,p) REACTIONS ON ^{114}Cd AND ^{115}In. Moorhead, J. B.; Cohen, B. L.; Moyer, R. A. (Univ. of Pittsburgh). Phys. Rev., 165: 1287-95(Jan. 20, 1968).

Energy and angular distributions from 12-MeV deuteron-induced (d,p) reactions on ^{114}Cd and ^{115}In were measured with ~8-keV energy resolution. In ^{115}In(d,p) essentially all components of the $(\pi g_{\frac{9}{2}}^{-1})$ $(vh_{11/2})$ configuration are located, and I values are estimated from sum rules. I values for many members of the $(\pi g_{\frac{9}{2}}^{-1})$ $(vd_{\frac{5}{2}})$ and $(\pi g_{\frac{9}{2}}^{-1})$ $(vs_{\frac{1}{2}})$ are determined from sum rules and the presence or absence of l = 0 and l = 2 mixing. As in a previous study of Pd(d,p), there is a large excess of $g_{\frac{9}{2}}$ and a large deficiency of $h_{11/2}$ strength relative to the isotonic tin nucleus (^{116}Sn) and expectations from nuclear-structure theory. The most obvious experimental explanations for this discrepancy are discussed and are found not to be applicable. (auth)

14038 E2 TRANSITIONS IN ODD-A NUCLEI. Rao, B. V. Narasimha; Jnanananda, Swami (Andhra Univ., Waltair, India). Phys. Rev., 165: 1296-8(Jan. 20, 1968).

The lifetimes of the 145-keV level of ^{141}Pr and the 159-keV level of ^{123}Te were measured; the values obtained were 1.91 ± 0.06 nsec and $19.85 \pm 1.0 \times 10^{-11}$ sec, respectively. The E2 transition rates, calculated from the lifetimes of the 145-keV (^{141}Pr), 159-keV (^{123}Te), 158- and 208-keV (^{199}Hg), and 129-keV (^{191}Ir) states were compared with the theoretical estimates given by Sorensen. (auth)

14039 ^{113}In(n,γ)^{114m,114g}In, ^{113}In(n,n')^{113m}In, ^{115}In(n,γ)^{116m,116g}In, AND ^{115}In(n,n')^{115m}In ACTIVATION CROSS SECTIONS BETWEEN 0.36 AND 1.02 MeV. Grench, H. A.; Menlove, H. O. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Phys. Rev., 165: 1298-1311(Jan. 20, 1968).

The ^{113}In(n,γ)^{114m,114g}In, ^{113}In(n,n')^{113m}In, ^{115}In(n,γ)^{116m,116g}In, and ^{115}In(n,n')^{115m}In activation cross sections were measured at 11 neutron energies between approximately 0.36 and 1.02 MeV. The full neutron energy spread was, on the average, about 0.06 MeV for the irradiations. All cross sections were measured relative to the ^{197}Au(n,γ)^{198}Au activation cross section. Normalizations of the relative cross sections for formation of ^{114g}In(72 sec) and of ^{116g}In(14 sec) were obtained from the results of thermal-neutron irradiations by using the reported thermal-cross-section values. Efficiency calibration of a NaI(Tl) crystal made it possible to obtain the magnitudes of the cross section for the other four reactions. Comparisons of the experimental results with calculations based on the statistical theory of nuclear reactions were made. (auth)

14040 ISOBARIC ANALOG RESONANCES IN ELASTIC AND INELASTIC SCATTERING OF PROTONS ON ^{208}Pb. Zaidi, S. A. A. (Univ. of Texas, Austin); Parish, J. L.; Kulleck, J. G.; Moore, C. Fred; von Brentano, P. Phys. Rev., 165: 1312-18(Jan. 20, 1968).

Excitation functions for proton elastic scattering and inelastic scattering to the 2.615-MeV (3$^-$), 3.198-MeV (5$^-$), 3.475-MeV (4$^-$), 3.709-MeV (5$^-$), 4.36-MeV, 4.48-MeV, and 4.69-MeV states in ^{208}Pb were measured at laboratory angles of 90, 125, 150, and 170°. The beam energy was varied in 25-keV steps between 14.2 and 18.2 MeV. In this range of bombarding energies, the isobaric analogs of the $g_{\frac{9}{2}}$, $i_{13/2}$, $d_{\frac{3}{2}}$, $s_{\frac{1}{2}}$, $g_{\frac{7}{2}}$, and $d_{\frac{5}{2}}$ single-neutron states of ^{209}Pb were observed. The elastic-scattering cross sections have been analyzed to yield the parameters of the $g_{\frac{9}{2}}$, $d_{\frac{3}{2}}$, $s_{\frac{1}{2}}$, $g_{\frac{7}{2}}$, and $d_{\frac{5}{2}}$ resonances. A simple interpretation of the decay of these resonances into the inelastic proton channels is offered, and the particle-hole structure of the excited states of ^{208}Pb is discussed. (auth)

14041 NUCLEAR MOMENT RATIOS IN ^{237}Np FROM MOESSBAUER SPECTRA. Stone, J. A.; Pillinger, W. L. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Phys. Rev., 165: 1319-26(Jan. 20, 1968).

Hyperfine structure was observed in Moessbauer spectra of the 59.54-keV γ ray of ^{237}Np in $NpAl_2$ and $NpCl_4$. At 77°K, $NpAl_2$ gave an unsplit absorption line; at 4.2 and 2.35°K, magnetic hfs extending over ≈18 cm/sec was observed. The partially resolved spectrum of $NpCl_4$ at 77°K was interpreted as pure quadrupole splitting; at 4.2°K, combined magnetic and quadrupole interactions were found. From these spectra, the following ratios were determined between the 59.54-keV level and the ground state of ^{237}Np: quadrupole-moment ratio +1.0 ± 0.1; magnetic-moment ratio +0.537 ± 0.005. Nuclear polarization in the Moessbauer spectra of $NpAl_2$ at 4.2 and 2.35°K enabled the magnetic-moment ratio to be determined uniquely. The results agree with theoretical predictions of the collective model if the odd-nucleon g factor is quenched to about 70% of the free-proton value. From a comparison of the present work with earlier measurements, a new estimate for the ^{237}Np ground-state magnetic moment is 2.8 nm. (auth)

14042 STATES OF ^{99}Mo. Evans, K. R. (Haverford Coll., Pa.); Ajzenberg-Selove, F.; Rosner, Baruch. Phys. Rev., 165: 1327-9(Jan. 20, 1968).

The level structure of ^{99}Mo was investigated by means of the reaction ^{97}Mo(d,p)^{99}Mo, using 10- to 12-MeV deuterons from the University of Pennsylvania tandem Van de Graaff and a broad-range spectrograph. Thirty states were observed in ^{99}Mo below $E_x = 3.8$ MeV. (auth)

14043 NEUTRON TOTAL CROSS SECTIONS OF EVEN ISOTOPES OF Zr IN THE ENERGY RANGE 2 TO 60 keV. Good, W. M.; Kim, H. (Oak Ridge National Lab., Tenn.). Phys. Rev., 165: 1329-36(Jan. 20, 1968). (ORNL-P-3359).

The zirconium nuclei are located at the beginning of the region of masses, viz., about 90 to 130, in which the measured strength functions are anomalously small, as far as the original optical model is concerned. The neutron resonance structure of $^{90,92,94,96}Zr$ was examined in the energy region 2 keV < E_n < 60 keV, and it was found that the s-wave strength function, in the region in which the s waves can be identified, has a mean value of $1.2 \pm 0.4 \times 10^{-4}$. At energies roughly above 25 keV, the ratio of the mean resonance width at 1 eV to the mean resonance spacing rises to a value of $2.5 \pm 0.6 \times 10^{-4}$; the latter value can not be uniquely interpreted because s-wave identification is not positive. Level densities for nuclides with neutron numbers in the vicinity of the magic number 50 are considered. (auth)

14044 EXCITATION OF ^{206}Pb, ^{207}Pb, ^{208}Pb, AND ^{209}Bi BY INELASTIC ELECTRON SCATTERING. Ziegler, J. F.; Petterson, G. A. (Yale Univ., New Haven). Phys. Rev., 165: 1337-51(Jan. 20, 1968). (YALE-2726-503).

High-resolution measurements of the differential cross sections for inelastic scattering of 28- to 73-MeV electrons by ^{206}Pb, ^{207}Pb, ^{208}Pb, and ^{209}Bi nuclei were analyzed by using a distorted-wave code to extract reduced nuclear radiative transition probabilities [B(EL)'s], and transition radii. The use of an irrotational and incompressible vibrating-liquid-drop model resulted in good fits to the data. In agreement with de-Shalit's weak-coupling core-excited state model, the B(EL)'s were found to be equal for the three lead isotopes within an experimental error of about 6% for the E2 excitations at about 4.1 MeV, and for the E4's at about 4.3 MeV. For all four isotopes the B(E3)'s at about 2.6 MeV were equal. Excitations of ^{208}Pb at 5.25 MeV (3^- or 4^+), 5.6 MeV (3^-), and 6.2 MeV (2^+ or 0^+) were observed. No strong E2 excitation of ^{208}Pb was identified between 6.2 and 18 MeV. A discussion of model and parameter dependence of the B(EL)'s and transition radii is given. (auth)

14045 HALF-LIVES OF 4+ AND 2+ ROTATIONAL STATES IN SEVERAL RARE-EARTH NUCLEI. Kugel, H. W.; Funk, E. G.; Mihelich, J. W. (Univ. of Notre Dame, Ind.). Phys. Rev., 165: 1352-60(Jan. 20, 1968). (COO-498-64).

A fast coincidence system was used to measure half-lives of 2+ and 4+ rotational states for several nuclei. The results of measurements to determine the value of $B(E2: 4 \rightarrow 2)/B(E2: 2 \rightarrow 0)$ for the ground-state band of several nuclei are presented. Half-life measurements were made for the first 2+ and 4+ states of the following nuclei: ^{156}Gd, ^{158}Gd, ^{166}Er, and ^{168}Er. The respective half-lives (nsec) with errors in the last significant figures in parentheses are 2.21(6), 2.52(8), 1.83(5), 1.88(5) for the 2+ states, and 0.118(7), 0.162(13), 0.117(7), 0.119(7) for the 4+ states. The respective $B(E2: 4 \rightarrow 2)/B(E2: 2 \rightarrow 0)$ values are 1.35(11), 1.32(11), 1.47(11), and 1.47(11). The half-lives of the 2+ states of ^{152}Sm, ^{154}Gd, and ^{160}Dy were measured to be 1.41(4), 1.21(4), and 2.01(6) nsec. The measured $B(E2: 4 \rightarrow 2)/B(E2: 2 \rightarrow 0)$ values were found to agree within errors with the rotational estimate of 1.43. These results and the data in the literature indicate that the value of $B(E2: 4 \rightarrow 2)/B(E2: 2 \rightarrow 0)$ is smaller than the rotational estimate for nuclei of $180 \leq A \leq 196$, but experimental uncertainties are still too large to permit a conclusion concerning any possible deviation at the low end of the rare-earth region. (auth)

14046 GROUND-STATE HYPERFINE STRUCTURE OF ^{165}Dy. Ramsey, Alan T.; Stein, Sanford (Univ. of California, Berkeley). Phys. Rev., 165: 1360-2(Jan. 20, 1968). (UCRL-17678).

The magnetic-dipole and electric-quadrupole hyperfine-interaction constants of the ground state of 2.3-h ^{165}Dy were measured to be $a = \pm 89.8 \pm 0.7$ MHz and $b = \pm 1521 \pm 30$ MHz, respectively. From these data, $\mu = -0.50$ nm and $Q = 2.8$ b, uncorrected, are calculated. (auth)

14047 INTERNAL-CONVERSION-ELECTRON STUDY OF THE DECAY OF ^{103}Ru. Manthuruthil, J. C. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio); Hennecke, Hans J.; Cothern, C. Richard. Phys. Rev., 165: 1363-70(Jan. 20, 1968).

The β decay of ^{103}Ru(39.6 d) was investigated with an iron-core, $\pi\sqrt{2}$ double-focusing β spectrometer. The internal-conversion-electron spectrum revealed the presence of γ rays of 609.89(24), 556.85(22), 496.88(16), 443.85(15), 294.88(16), 53.11(3), and 39.55(4) keV. No new lines with an intensity greater than 1.6% of the 497K line were found. The 67K line was found to have an intensity less than 0.17%, and the 322K and 362K lines an intensity less than 0.3% of the 497K line. Limitations on the multipolarities and mixing ratios of some of the transitions were determined through K/L- and L-subshell ratios, and through internal-conversion-coefficient measurements. The multipolarities obtained for the seven observed transitions were compared with γ-γ angular-correlation results. This resulted in the spin-parity assignments of $7^+/2$, $7^+/2$, and $7^-/2$ for the 39.55(4)-, 92.66(5)-, and 649.48(24)-keV states, respectively. The 536.47(16)-keV level is shown to have a spin parity of either $3^+/2$ or $7^-/2$. (auth)

14048 MULTILEVEL ANALYSIS OF THE ^{239}Pu FISSION CROSS SECTION FROM 14 TO 90 eV. Farrell, J. A. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 165: 1371-4 (Jan. 20, 1968). (LA-DC-8528).

The ^{239}Pu fission cross section was fitted with a multilevel R-matrix formula from a neutron energy of 14 to 90 eV. Spin assignments were made from the interference between resonances. The average fission widths are 1033 MeV with at least two open fission channels for the 0^+ spin state, and 66 MeV and one channel for the 1^+ state. The number of undetected levels is deduced from the statistical distributions of resonance parameters. (auth)

14049 RANGE-ENERGY STUDIES OF Po AND At RECOILS IN Al AND Al_2O_3. Croft, P. D.; Street, Kenneth Jr. (Univ. of California, Berkeley). Phys. Rev., 165: 1375-80(Jan. 20, 1968).

Range-energy curves for 6- to 12-MeV At and Po recoils in Al leaf and Al_2O_3 were determined using nuclear reactions of ^{16}O with Ir to produce the recoils. Al leaf foils of 0.15 mg/cm^2 and Al_2O_3 foils of 0.07 mg/cm^2 were used. Ranges in mg/cm^2 are 7–11% larger in Al_2O_3 than in Al. Range-straggling parameters are about 25% smaller in Al_2O_3. The results are compared with theoretical predictions. (auth)

14050 RECOIL STUDIES OF NUCLEAR REACTIONS OF ^{209}Bi AND ^{208}Pb WITH ^{16}O. Croft, P. D. (State Univ. of New York, Stony Brook. Univ. of California, Berkeley); Alexander, John M.; Street, Kenneth Jr. Phys. Rev., 165: 1380-90(Jan. 20, 1968).

Projected range distributions in stacked Al_2O_3 foils were determined for the α-active products from the reactions $^{209}Bi(^{16}O,X)Y$ at various bombarding energies from 76 to 163 MeV and $^{208}Pb(^{16}O,X)Y$ at 123 and 163 MeV. The products Y identified were $^{206,208,210}Po$, $^{209,211}At$, $^{210,211,212}Rn$, and ^{212}Fr. Stacked Al leaf foils were used for further study of the particularly interesting region of bombarding energies near the Coulomb barrier. Here, projectile residues are ejected in a preferentially backward direction, giving the recoiling products, Y, energies and ranges up to about three times the values possible from a compound-nucleus reaction. For bombarding energies above about 1.3 times the Coulomb barrier, the range distributions for the products typically peak at ranges from $\frac{1}{4}$–$\frac{1}{2}$ the compound-nucleus range, but most have a long-range tail. With the help of angular-distribution experiments, it was possible to clarify the mechanisms in a qualitative way. No evidence was obtained which indicates that α transfer might be a preferred mode. Improved half-lives were obtained for $^{210,211,212}Rn$. These are 2.42 ± 0.05 h, 14.6 ± 0.6 h, and 25.5 ± 1.0 min, respectively, where the uncertainties are standard deviations. (auth)

14051 INVESTIGATION OF $^{128}Ba \rightarrow ^{128}Cs \rightarrow ^{128}Xe$ DECAY. Kucarova, T.; Zvolska, V.; Kracik, B.; Mastalka, A. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Czech. J. Phys., 18: 24-33(1968). (In Russian).

The gamma ray spectrum of ^{128}Ba + ^{128}Cs was studied by means of a Ge(Li) detector. Thirty new transitions were found. Several regions of the conversion-electron spectrum were studied by means of a beta spectrometer with a resolving power of 0.12% and conversion lines K 965.5 keV and K 1134.8 keV were observed for the first time. In a proposed scheme of excited levels of ^{128}Xe new levels 2356 keV and 2474 keV are introduced. The electron-capture branching ratios as well as the corresponding log ft values were determined. An analysis of the spins and parities and a classification of the ^{128}Cs and ^{128}Xe levels are given. (auth)

14052 DECAY OF ^{108m}Ag. Kracikova, T. I. (Technical Univ., Prague); Kracik, B. Czech. J. Phys., 18: 143-9(1968). (In Russian).

The γ-spectrum of the long-lived isomer of ^{108}Ag ($T_{\frac{1}{2}} \geq 5$ years) was studied by means of Ge(Li) semiconductor detectors. Eight gamma transitions were found with energies of 79.5, 405.7, 433.7, 613.5, 633.0, 722.6, 836.5, and 1020 keV and corresponding relative intensities of 0.083, 0.008, 1, 1.05, 0.0018, 1.02, 0.0006, and 0.010. The conversion coefficients and multipolarities were determined for transitions of 79.5, 613.5, and 722.6 keV. In the decay scheme of ^{108m}Ag the sequence of the levels 4^+ (1047 keV) and 0^+ (1049 keV) is given and the existence of the levels 1454 keV and 1469 keV is confirmed. Spin and parity 2^- were ascribed to the 80 keV level of ^{108}Ag on the basis of the multipolarity of the 79.5 keV transition. (auth)

14053 DECAY OF ^{130}Xe STUDIED WITH ISOTOPE SEPARATOR ON-LINE TECHNIQUES. Holm, S.; Faegerquist, U.;

Kopff, F. (Research Inst. of National Defence, Stockholm. Research Inst. for Physics, Stockholm). Ark. Fys., 34: 447-57(1967).

The decay of 41-sec ^{139}Xe was studied using a technique of continuous production, separation, and detection at the Stockholm electromagnetic isotope separator. A number of new transitions were found, and a level scheme of ^{139}Cs is proposed. The level structure is compared with that of the single-closed-shell nucleus ^{139}Cs. (auth) (Sweden)

14054 DECAY PROPERTIES OF ^{147}Nd. Baecklin, A. (Uppsala Univ.); Malmskog, S. G. Ark. Fys., 34: 459-65(1967).

Conversion-electron lines and gamma lines from the decay of ^{147}Nd were studied at high resolution with a double-focusing beta spectrometer and a Ge(Li) detector. A new transition was found at 589.0 keV, and multipolarities were determined for a number of transitions. The parity of the 489-keV level was found to be positive. (auth) (Sweden)

14055 STUDY OF THE EXCITED LEVELS OF ^{155}Gd OBTAINED FROM ^{155}Eu. Foin, C.; Oms, J.; Barat, J.-L. (Faculte des Sciences, Grenoble, France). J. Phys. (Paris), 28: 861-7 (Nov.-Dec. 1967). (In French).

The β^- decay ^{155}Eu → ^{155}Gd was investigated by means of a double-focusing iron-free magnetic β spectrometer. The relative intensities of the different K- and l-conversion lines are tabulated. The photon spectrum was studied by external conversion. The internal conversion coefficients α_K (86.52) = 0.373 ± 0.026 and α_K (105.28) = 0.236 ± 0.021 are deduced from those measurements. The coincidence between a 21-keV transition and the 86.5-keV transition is shown by means of an electrostatic β spectrometer equipped for electron-gamma coincidence. (auth)

14056 NATURE OF THE FIRST 4^+ STATES OF EVEN TIN ISOTOPES. Rahmouni, O.; Abou-Leila, H. (Institut de Physique Nucleaire, Orsay, France). J. Phys. (Paris), 28: 857-60(Nov.-Dec. 1967). (In French).

Half-lives of the 4^+ states in ^{118}Sn and ^{120}Sn were measured using a time-to-amplitude converter. The experimental results are compared with theoretical estimations in order to explain the nature of the 4^+ states in spherical nuclei. The half-life of the 5^- state in ^{120}Sn was measured. A value of $5.5 \pm 0.25 \times 10^{-9}$ sec, in good agreement with the previous measurements, is obtained. (auth)

14057 ISOSPIN DEPENDENCE OF THE NUCLEAR POTENTIAL FROM THE DATA ON THE TOTAL NEUTRON CROSS-SECTION OF ISOTOPES. Dukarevich, Yu. V.; Dyumin, A. N.; Kaminker, D. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 217-28 (Feb. 1967). (In Russian).

The results are given of total neutron cross-section measurements carried out for the stable isotopes of Ni, Zn, Ag, Cd, In, Sn, Sb, and Te at a neutron energy of 14.2 MeV. An analysis on the basis of the optical model, together with the available data on the full reaction cross-section and differential elastic neutron scattering cross-sections for the elements of natural isotopic composition, has produced the real and imaginary parts of the isospin term of the optical potential. (JPRS)

14058 NUCLEAR g-FACTOR OF THE 356-keV LEVEL IN ^{196}Pt AND THE INTERNAL FIELD ON MERCURY IN IRON. Murray, J.; McMath, T. A.; Cameron, J. A. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 46: 75-8(Jan. 1968).

The source material for the platinum experiment was ^{196}Au produced by the (d, 2n) reaction on natural platinum. The g-factor of the first excited state in ^{196}Pt is g = 0.265 ± 0.035. The value for the hyperfine field in mercury in iron at room temperature is $H_{Fe}^{Hg} = -490 \pm 125$kOe. (F.S.A.)

14059 IDENTIFICATION OF ^{111}Te BY DAUGHTER PRODUCTS OF PROTON DECAY. Bogdanov, D. D.; Bacho, I.; Karnaukhov, V. A.; Petrov, L. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1113-16(Dec. 1967). (In Russian).

To identify the delayed proton emitter with $T_{\frac{1}{2}} \simeq 19$ sec produced in the reaction ^{102}Pd + ^{12}C, radioactive products of its decay were investigated. The γ spectrum of recoil nuclei shows clear peaks with 290 ± 27 and 660 ± 28 keV. The half-lives of these activities are 3.6 ± 0.6 and 4.0 ± 1.0 hours, respectively. This radiation is assigned to the isotopes ^{110}Sn and ^{110}In which are the decay products of the ^{111}Te, the emitter of delayed protons. (auth)

14060 NEW ISOTOPE ^{242}Cf. Ilyushchenko, V. I.; Miller, M. B.; Mikheev, V. L.; Shchegolev, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1117-18(Dec. 1967). (In Russian).

When irradiating ^{235}U with ^{12}C ions a new α-emitter with the energy E = 7.37 ± 0.03 MeV and $T_{\frac{1}{2}} = 3.7 \pm 0.3$ min was found. From the energy and half life of α decay, from the dependence of its yield on the energy of the ^{12}C ions, and from comparison of its production cross sections with the reaction ^{238}U (^{12}C, 5n), the emitter is identified as a new isotope ^{242}Cf about which there is no data in the literature. (auth)

14061 ELASTIC SCATTERING OF ELECTRONS WITH THE ENERGY 225 MeV ON THE NUCLEUS ^{139}La AND NUCLEAR RADIUS. Shevchenko, N. G.; Afanas'ev, N. G.; Savitskii, G. A.; Khvastunov, V. M.; Gul'karov, I. S.; Omelaenko, A. S.; Kovalev, V. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1119-23(Dec. 1967). (In Russian).

The differential cross section for elastic scattering of electrons on the ^{139}La nucleus at the energy 225 ± 0.7 MeV and at angles of 20 to 110° was measured. Theoretical calculations was performed in the framework of high-energy approximation assuming that the ^{139}La nucleus charge is described by two-parameter Fermi model. The parameters of the Fermi charge distribution for the ^{139}La were obtained: c = 5.71f and t = 2.35f. (auth)

14062 SPECTRA AND ANGULAR DISTRIBUTIONS OF α PARTICLES FROM THE INTERACTION OF ACCELERATED IONS ^{22}Ne AND ^{40}Ar WITH THE NUCLEI Au AND Th. Kapustsik, A.; Perel'igin, V. P.; Tret'yakova, S. P.; Ukraintseva, L. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1142-8(Dec. 1967). (In Russian).

The angular distributions and spectra of alpha particles from ^{20}Ne reactions with Au at 110 and 120 MeV, ^{20}Ne reactions with Th at 115 and 140 MeV, and ^{40}Ar reactions with Th at 240 MeV were measured. The components corresponding to the evaporation from compound nuclei and to direct processes were separated. (D.C.W.)

14063 DEPENDENCE OF THE MEAN KINETIC ENERGY OF FRAGMENTS ON THE EXCITATION ENERGY OF THE FISSIONED NUCLEUS. Bol'shov, V. I.; Kuznetsov, V. F.; Smirenkin, G. N.; Ermagambetov, S. B.; Okolovich, V. N. Yadern. Fiz., 6: 1162-6(Dec. 1967). (In Russian).

The mean kinetic energy of fragments at fission of ^{233}U and ^{235}U by 1.5-MeV neutrons is considered. The results of the direct measurements and the information obtained from the data on the mean number of secondary neutrons are given. Various conceptions are considered that relate the origin of the nonregular variations of the quantity investigated with the discrete structure of the spectrum of the fission channels. The experimental results are shown to be explicable on basis of the alternative assumptions about properties of the coupling between the deformation and the nucleon degrees of freedom in the fissile nucleus. (auth)

14064 ENERGY AND MASS DISTRIBUTIONS OF FRAGMENTS AT FISSION OF ^{233}U AND ^{235}U BY FAST NEUTRONS. D'yachenko, P. P.; Kuz'minov, B. D.; Mikhailov, V. B.; Semenkov, V. F.; Senchenko, V. I.; Utyuzhnikov, A. N. Yadern. Fiz., 6: 1167-73(Dec. 1967). (In Russian).

Kinetic energy and mass distributions were measured for fragments at fission of ^{233}U by 0.43-, 0.63-, and 1.10-MeV neutrons and at fission of ^{235}U by 0.10-, 0.26-, 0.70-, and 1.30-MeV neutrons. Variations of yields and kinetic energies are ascribed to an influence of intermediate states of the fissile nuclei. It is noted that the variations of the kinetic energy depends on the fragment masses. (auth)

14065 PAIR CORRELATIONS OF SUPERCONDUCTING TYPE FOR THE NUCLEI IN THE REGION $100 < A < 256$. Malov, L. A.; Solov'ev, V. G.; Khristov, I. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 1186-96(Dec. 1967). (In Russian).

On the basis of superfluid nuclear model, pair energies for spherical and deformed nuclei in the region $100 < A < 256$ were calculated. It was shown that the pair energies calculated with the constants $G_Z = 27\ A^{-1}$ MeV, $G_N = 23\ A^{-1}$ MeV for all nuclei in the region $150 < A < 256$ are in sufficiently good agreement with experimental data. For the nuclei in the region $100 < A < 150$ values G_Z and G_N decrease and approach each other. Correlation functions for the ground states of even-even and odd nuclei are obtained, and singularities of their behavior are discussed. Schemes of one-particle levels and calculated values of chemical potentials are given. The material is presented in a form that is convenient to use for different numerical estimations when studying the properties of nuclei under consideration. (auth)

14066 CORRELATION OF RESONANCE PARAMETERS. Gai, E. V.; Rabotnov, N. S. Yadern. Fiz., 6: 1313-14(Dec. 1967). (In Russian).

The spin dependence of the mean magnitudes of various partial

widths of neutron resonances as a function of certain transitions was examined. The causality of the observed correlations between various arbitrary magnitudes describing neutron resonances was studied, and it was shown that the correlation coefficient, in many cases, offers sufficient data for determining the difference between mean resonance parameters of the two-spin subsystems. The coefficient of two arbitrary variables x and y is equal to $r = (xy-\bar{x}\bar{y})/[(x^2-\bar{x}^2)(y^2-\bar{y}^2)]^{1/2}$, where x and y are magnitudes of neutron s resonance). A correlation of $x = \Gamma_f$ and $y = 2g\Gamma_n^0$ is examined for nuclear targets of ^{239}Pu and ^{233}U. (R.V.J.)

Nuclear Theory

Refer also to abstracts 13716, 13717, 13728, 13870, 13899, 13927, 13931, 13947, 13949, 13961, 13985, 13991–13993, 13997, 14020, 14057, and 14065.

14067 (BMwF-FBK-67-81) UNTERSUCHUNGEN ZUM CLUSTERMODELL DES ATOMKERNS, JAHRESBERICHT 1965/1966. (Report on Investigations on the Cluster Model of the Atomic Nucleus, 1965/1966). (Tuebingen Univ. (West Germany). Institut fuer Theoretische Physik). Sept. 1967. 71p. (In German). Dep.

Investigations in the framework of the cluster model of the atomic nucleus are reported. Mathematical aspects of refined cluster-model calculations; the structure of ^{3}H, ^{3}He, ^{4}He, ^{6}Li, ^{7}Li, ^{7}Be; reaction theory; electromagnetic transitions in ^{6}Li; the N–N soft-core central potential; the N–N spin-orbit potential; the influence of the Pauli principle on nuclei; ^{3}He–^{3}He scattering; isospin mixing in ^{8}Be; the energy width of virtual resonance levels; and asymmetric fission were studied. (auth)

14068 (BMwF-FBK-67-82) DYNAMISCHE THEORIE DER KERNREAKTIONEN IM RAHMEN DES CLUSTERMODELLS. (Dynamical Theory of Nuclear Reactions in the Framework of the Cluster Model). Benoehr, H. C. (Tuebingen Univ. (West Germany). Institut fuer Theoretische Physik). Sept. 1967. 122p. (In German). Dep.

A unified theory of nuclear structure and nuclear reactions is formulated in the framework of nonrelativistic quantum mechanics. The Pauli principle is included without any restrictions. Approximate solutions of the Schroedinger equation are constructed by means of the Rayleigh-Schroedinger variational principle and the use of properly chosen trial functions. From the ideas of the cluster model, a systematic procedure for the construction of trial functions is derived. A differentiation between direct processes and compound processes results from the theory in a quite natural way. The theory of compound resonances is discussed in detail for an isolated resonance. (auth)

14069 (COO-238-51) FINAL REPORT [ON LOW ENERGY NUCLEAR PHYSICS AND PHYSICS OF ATOMIC AND IONIC BEAMS]. (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies). Dec. 27, 1967. Contract AT(11-1)-238. 7p. Dep. CFSTI.

A summary of the completed research program on low-energy nuclear reactions induced by light charged particles and on the interaction of atomic and ionic beams with matter is presented. (D.C.W.)

14070 (EUR-3668) RELATIVISTIC CALCULATIONS OF KINEMATIC PARAMETERS FOR NUCLEAR REACTIONS. Horstmann, H.; Liskien, H. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Oct. 6, 1967. 32p. Dep.

A FORTRAN program for relativistic calculations of general kinematic parameters for nuclear reactions is described. The usefulness of the program is demonstrated by means of calculations for neutron-producing reactions. (auth)

14071 (IPNO/TH-110) ISOSPIN AND NUMBER-CONSERVING TREATMENT OF PAIRING CORRELATIONS IN NUCLEI. Campi, X.; Vucetich, H.; Jean, M. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). Nov. 1967. 29p. Dep.

A previous study of the pairing interaction between identical particles by means of the equations of motion is extended to the case of unlike nucleons interacting through a charge-independent force. By comparison with the Hecht model for which exact numerical results are available, the results are seen to be a compromise between those of the BCS and Lipkin-Nogami methods. (auth)

14072 (ITF-67-12) PRIMENENIE TEORII VOZMUSHCHENII PO OBRATNYM STEPENYAM PARAMETRA VZAIMODEISTVIYA K SISTEME TREKH NUKLONOV. (Application of Perturbation Theory to Inverse Powers of the Interaction Parameters for a System of Three Nucleons). Filippov, G. F.; Ovcharenko, V. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 15p. (In Russian). Dep.

An approximate method of solving the problem of bound states of a system of N particles is developed in which the expansions in inverse powers of the interaction parameter are used. The wave functions of the two-body oscillator potential system are chosen as zero-order approximations. To show the effectiveness of the method, the binding energy of a three-particle system is calculated. (auth)

14073 (JINR-E4-3624) MANY PARTICLE TRANSFER REACTIONS. Dumitresku, O. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 22p. Dep.

An explicit expression for the matrix element for the (^{6}Li,p) stripping reaction with finite-range interaction for both spherical and deformed nuclei is given. (auth)

14074 (JINR-E4-3629) NUCLEAR OCTUPOLE DEFORMATIONS. Vogel, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 22p. Dep.

The dependence of the nuclear potential energy on the parameters of the quadrupole and octupole deformation for nuclei in the $218 \leq A \leq 232$ region is investigated. The energy is calculated in the framework of the superfluid nuclear model. The minimum of the potential energy surface is obtained for $\beta_3 = 0$, i.e., there are no nuclei with nonzero equilibrium octupole deformation in the region considered. The dependence of the energy on the deformation differs essentially from the simple parabolic one; particularly a term of the type $C_{23} \cdot \beta_2 \cdot \beta_3$ is present in $E(\beta_2, \beta_3)$ leading to an asymmetric energy surface and to an interaction between β vibrations and octupole vibrations. (auth)

14075 (JINR-P4-3650) N-ZAPRESHCHENNYE β-PEREKHODY V DEFORMIROVANNYKH YADRAKH V PRIBLIZHENII KONECHNOGO POTENTSIALA S RAZMYTYM KRAEM. (N-Forbidden β-Transitions in Odd-Mass Nuclei in the Approximation of the Finite Diffused Potential). Gareev, F. A.; Kalinkin, B. N.; Pyatov, N. I.; Chernei, M. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 17p. (In Russian). Dep.

N-forbidden β transitions in odd-mass rare-earth nuclei were considered. The single-particle wave functions of the Woods-Saxon's potential including $N \pm 2$ shell states admixtures were used in calculations. The pairing correlation effects were taken into account. The finite log-ft values are obtained for such transitions while the Nilsson model predicts the zero transition probability. The calculated log-ft values satisfactorily fit the experimental data. (auth)

14076 (LYCEN-6743) GRAPHICAL TREATMENT OF INELASTIC NUCLEAR SCATTERING THEORY. El-Baz, E.; Castel, B. (Lyon Univ. (France). Institut de Physique Nucleaire). June 12, 1967. 15p. Dep.

The theory presented deals with the angular momentum aspects of nuclear inelastic scattering. In a preceding article, a graphical approach analogous to the one used here described a reaction characterized by a well-defined intermediate state. Here, no such state is considered, and it is shown that the graphical description permits a clear view of angular, tensorial, and radial dependences of the interaction matrix and the determination of the probability of observation when polarization is included. (auth)

14077 (NYO-1082-10) SURVEY OF (n,z) REACTIONS. Peck, R. A. Jr. (Brown Univ., Providence, R. I.). June 1967. Contract AT(30-1)-1082. 21p. (CONF-670615-4). Dep. CFSTI.

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md.

A survey of nuclear research using (n,α), (n,d), (n,p), (n,t), and (n,He-3) reactions at neutron energies below about 20 MeV is presented. The information that was obtained on the reaction mechanisms and on nuclear parameters is summarized. (D.C.W.)

14078 (TID-24250) GENERAL NUCLEAR REACTION STRIPPING AND PICKUP COMPUTER PROGRAM. [Progress Report]. Smith, William R. (Oxford Univ. (England). Nuclear Physics Lab. University of Southern California, Los Angeles). Aug. 31, 1967. Contract AT(04-3)-136. 59p. (USC-136-133). Dep. CFSTI.

A description and listing are presented of an optical-model DWBA program in which, for the case of stripping, the transferred particle is initially bound with $l = 0$ in the bombarding particle by a central Hulthen potential and is bound in its final arbitrary-l state to the target by a Woods-Saxon potential. Finite-range interactions and nonlocal potentials are included, but spin-

orbit coupling is not. The program is written in standard FORTRAN. (auth)

14079 (UCRL-16348) Γ_n/Γ_f SYSTEMATICS AND ITS IMPLICATION IN THE SYNTHESIS OF THE HEAVIEST NUCLIDES. Sikkeland, Torbjorn (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1965. Contract W-7405-eng-48. 32p. Dep. CFSTI.

The following expression for the ratio of the level width for neutron evaporation to that of fission: $\Gamma_n/\Gamma_f = 0.31A^{\frac{1}{3}} \exp [(E_f^R - B_n - \Delta_s + \Delta)/0.51]$ is found to fit experimental values for nuclei in the region $90 \leq Z \leq 104$ and $227 \leq A \leq 264$. Values for B_n, the neutron binding energy, and Δ_s, the sum of the shell and pairing corrections for the ground-state nucleus, were taken from the compilations of Cameron. The parameter Δ has the value 0.0, −0.6, 0.9, and 0.3 MeV for an ee, eo, oe, and oo nucleus, respectively. The quantity E_f^R is given by the formula: $E_f^R = A^{\frac{2}{3}}[72.94(1-x)^3 - 479.6(1-x)^4 + 952.2(1-x)^5]$. The fissility parameter, x, is defined as: $x = c(Z^2/A)(1 - K[(N-Z)/A]^2)^{-1}$ where $c = 1.931 \times 10^{-2}$ and K = 1.791. With the expression $x = (Z^2/A)/(Z^2/A)_{crit}$, where $(Z^2/A)_{crit}$ is a constant, no fit to experimental data was obtained. The relation between measured fission barriers E_f, and E_f^R is found to be $E_f = E_f^R - \Delta_s + \Delta_p^s$, where Δ_p^s, the pairing energy at saddle, is 0.0, 1.0, and 2.0 MeV for an ee, oA, and an oo nucleus, respectively. The energy gaps for the nucleus in the ground state are 1.5 and 0.75 MeV for an ee and an oA nucleus, respectively, relative to that of an oo nucleus. The corresponding gaps at saddle are 1.7 and 0.85 MeV. The experimental Γ_n/Γ_f data used in the comparison include all those obtained in reactions with γ, n, p, d, α, and heavy ions in which the nuclei are excited in the 10 to 115 region. No variation of Γ_n/Γ_f with excitation energy or angular momentum is observed. The effects of the 152-neutron subshell on Γ_n/Γ_f are clearly demonstrated. Calculations suggest that, with present day accelerators, elements past Z = 107 will be produced with yields so low that they will escape detection. However, with machines that accelerate beams of superheavy ions, elements in the region of the hypothetical double shells at Z = 126 and N = 184 may be synthesized in sufficient quantities. (auth)

14080 (ANL-Trans-550) ANGULAR ANISOTROPY AND EFFECTS OF PAIR CORRELATION OF NUCLEONS IN NUCLEAR FISSION BY NEUTRONS. Smirenkin, G. N.; Nesterov, V. G.; Tishin, A. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report FEI-67. 21p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

The energy dependence of the angular anisotropy of fission of ^{233}U, ^{235}U, ^{239}Pu by neutrons and of ^{233}U by α particles is discussed. The dependence of the mean square of the projection of the moment of the compound nucleus upon the fission axis $\overline{K^2}$ on the excitation energy E in the saddle point has been obtained in accordance with the statistical theory of angular distributions of fission fragments. The analysis of the dependence $\overline{K^2}(E)$ permitted to determine for the ^{240}Pu nucleus in the deformed transition state the critical energy $E_{kp} = 9.5 \pm 3$ MeV at which there occurs a transition from the superfluid phase into the normal phase and the magnitude of the energy gap in the spectrum of internal excitations $2\Delta_0 = 1.5 \pm 0.3$ MeV. The values obtained are considerably lower than the last data available on these quantities. It is shown that the magnitude of deviations of $K_0^2(E)$ from the Fermi gas model, caused by the correlation effects of nucleons is much smaller than had been assumed earlier. (auth)

14081 RELATION BETWEEN THE OPTICAL POTENTIAL FOR SPHERICAL AND DEFORMED NUCLEI. Glendenning, N. K.; Hendrie, D. L.; Jarvis, O. N. (Univ. of California, Berkeley). Phys. Lett., 26B: 131-3(Jan. 8, 1968). (UCRL-17935).

It is shown that when the contribution of the strong collective states to the optical potential is removed by treating them explicitly through solution of the coupled equations describing the scattering, the resulting optical potential is valid for both spherical and deformed nuclei over a broad mass range in the rare earth region. In a search for the nuclear shape in the deformed region, this has the very important effect of removing the optical parameters from the list of free parameters. (auth)

14082 REAL PART OF THE PROTON OPTICAL MODEL POTENTIAL. Perey, C. M.; Perey, F. G. (Oak Ridge National Lab., Tenn.). Phys. Lett., 26B: 123-6(Jan. 8, 1968). (ORNL-P-3497).

The analysis of 11-MeV proton differential elastic scattering and polarization from over 20 isotopes in the mass region between ^{48}Ti and ^{76}Ge reveals an average set of parameters substantially different from those found at higher energies. The variation of the real well depth as a function of mass number is very smooth but does not follow the expected isotopic spin dependence of the potential. (auth)

14083 COULOMB DISTORTION AND NUCLEAR STIFFNESS IN SUPERHEAVY-ION REACTIONS. Wong, C. Y. (Oak Ridge National Lab., Tenn.). Phys. Lett., 26B: 120-2(Jan. 8, 1968). (ORNL-P-3555).

It is shown that since the amount of Coulomb distortion in superheavy-ion reactions is very sensitive to the nuclear stiffness, a simple liquid-drop model is inappropriate in studying Coulomb distortion. (auth)

14084 TIME REVERSAL AND DETAILED BALANCE IN DWBA. Robson, D. (Florida State Univ., Tallahassee). Phys. Lett., 26B: 117-19(Jan. 8, 1968).

The effect of time reversal odd interactions on detailed balance for direct nuclear reactions is discussed using DWBA theory. Reactions involving well-localized interactions beyond the nuclear surface are found to be insensitive to the time odd interactions. (auth)

14085 ANGULAR CORRELATION OF GAMMA RAYS FOLLOWING THE PICK-UP DIRECT NUCLEAR REACTIONS. Kaneko, Tsuneo (Niigata Univ., Japan). Sci. Rep. Niigata Univ., Ser. B, No. 1, 1-11(Apr. 1967).

The angular correlation functions of γ rays following pick-up direct nuclear reactions are evaluated and discussed. The distorted-wave Born approximation is used, the distorted potentials for the incident and outgoing particles including the spin-orbit coupling. The angular correlation functions obtained are applied to the reaction $^{13}C(^3He, \alpha\gamma_{4.43\ MeV})^{12}C$, the results being compared with those for the optical potentials without the spin-orbit coupling. (NSA of Japan)

14086 PAIRING EFFECTS IN THE ^{20}Ne HARTREE–FOCK WAVE FUNCTION. Stamp, A. P. (Univ. of Auckland, N. Z.). Phys. Lett., 26B: 58-9(Dec. 25, 1967).

The correction to the Hartree–Fock wave function due to pair correlations is calculated. The effective t interaction derived from the Yale two nucleon potential is used for the two body interaction. (auth)

14087 SU_3 SYMMETRY AND REALISTIC INTERACTIONS. Flores, J. (Princeton Univ., N. J.); Perez, R. Phys. Lett., 26B: 55-7(Dec. 25, 1967).

The energy levels and wave functions are calculated for systems of three and four particles in the 2s – 1d shell using an effective interaction determined from the Hamada–Johnston potential and wave functions classified in the SU_3 scheme. It is shown that the degree of SU_3 symmetry violation is very low for these cases that correspond to low isospin values. (auth)

14088 CLUSTER REPRESENTATIONS OF RESONANCE REACTIONS. Benoehr, H. C.; Wildermuth, K. (Univ., Tuebingen, Ger.). Phys. Lett., 26B: 68-70(Dec. 25, 1967).

It is shown that resonance reactions (Breit–Wigner formulae) are contained in the dynamical theory of nuclear reactions based on the Raleigh–Schrödinger variational principle. The procedure of constructing physical resonance structures Ψ_λ^c and deriving the corresponding Breit–Wigner formulae is given for reactions with two open channels. It is shown that the procedure can be generalized to any number of open and closed channels. (S.F.L.)

14089 HIGHER ORDER CORE POLARIZATION PROCESSES AND EFFECTIVE INTERACTIONS IN NUCLEI. Kuo, T. T. S. (Princeton Univ., N. J.). Phys. Lett., 26B: 63-8(Dec. 25, 1967). (PUC-937-281).

In the contributions to the effective nucleon-nucleon interaction coming from core polarization involving positive parity excitations, it is found adequate to employ lowest-order perturbation theory (one "bubble"). This is checked by explicitly constructing the core polarization phonons and coupling them with the two particles. When the exchange of negative parity phonons is involved, it is important to include also the higher order bubble diagrams. Applications were made for nuclei in the 0p, 0d, and 1s shell. (auth)

14090 MEASURES FOR GROUP-SYMMETRY BREAKING IN NUCLEI. French, J. B. (Univ. of Rochester, N. Y. Univ. of Mexico, Mexico). Phys. Lett., 26B: 75-7(Dec. 25, 1967).

An orthonormal separation of the Hamiltonian operator into parts which preserve and break a given symmetry is introduced, along the norms for measuring the separate components. The procedure takes full account of the restrictions imposed by the exact symmetries. (auth)

14091 MAGNETIC MOMENT OF A "HEATED" NUCLEUS. Kuklin, R. N. Yadern. Fiz., 6: 969-72(Nov. 1967). (In Russian).

The mean value and fluctuations of the nuclear magnetic moment in an excited state with an excitation energy of the order of binding energy of neutrons B_n ("heated" nuclei) are calculated. (auth)

14092 AVERAGE FIELD OF NEUTRON AND PROTON SHELLS WITH N > 126 AND Z > 82. Chepurnov, V. A. Yadern. Fiz., 6: 955-60(Nov. 1967). (In Russian).

Parameters of the average nuclear field of the Woods–Saxon type were determined for which both neutron and proton one-particle states are satisfactorily described. The Coulomb repulsion was determined by means of nonuniform charge distributions known from the Hofstadter experiments. The energy change of the odd particle due to the addition of two particles of different types was considered. For the potential given, the calculation shows that the hyperheavy nucleus $^{298}114$ must possess the closed shells N = 184 and Z = 114. (auth)

14093 DISTRIBUTION OF NUCLEONS IN NUCLEI. Khrylin, B. A. (Moscow Engineering Physics Inst.). Yadern. Fiz., 6: 949-54(Nov. 1967). (In Russian).

By means of the finite Fermi-system theory, the equation for the difference between the density of neutrons and protons in nuclei is derived. The analytical solution of this equation is obtained. The numerical solution for a series of nuclei is given. The rms neutron radius of a nucleus at a given rms proton radius is given. (auth)

14094 EQUIVALENT LOCAL POTENTIAL. Gorodkov, S. S. Yadern. Fiz., 6: 945-8(Nov. 1967). (In Russian).

The problem of the equivalent local potential is solved in the first approximation assuming slow variation of the potential. The empirical for the Perey effect is confirmed theoretically. The Perey–Buck formula is shown to be valid also in this higher approximation. The range of the equivalent local Woods–Saxon potential is found. (auth)

14095 ANGULAR ANISOTROPY AND NUCLEON PAIR CORRELATION EFFECTS IN NUCLEAR FISSION. Smirenkin, G. N.; Nesterov, V. G.; Tishin, A. S. Yadern. Fiz., 6: 921-9(Nov. 1967). (In Russian).

The energy dependence of the rms value of the momentum projection of a nucleus undergoing fission on the fission axis $\overline{K^2} = K_0^2$ was analyzed. The data on the angular anisotropy of the fission of ^{239}Pu by neutrons and ^{233}U by α particles were used. The revision of the previous analysis resulted in the decrease of energy of the phase transition E_{kp} up to 9.5 ± 3 MeV and of the value of the energy gap in the spectrum of internal excitations 2Δ up to 1.5 ± 0.3 MeV. It is shown that the magnitude of deviations $K_0^2(E)$ from the Fermi-gas model due to the nucleon pair correlation effects is considerably less than was previously assumed. (auth)

14096 DEUTERON STRIPPING REACTIONS ON DEFORMED NUCLEI. Luk'yanov, V. K.; Petkov, I. Zh. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 988-91 (Nov. 1967). (In Russian).

The problem of stripping reactions on deformed nuclei is considered in the adiabatic approximation within the framework of the distorted-wave method. The selection rules are obtained. It is shown that the data evaluation presently used is not accurate. (auth)

14097 STRIPPING WITH TWO NUCLEON TRANSFER. Kadmenskii, S. G. (Voronezh State Univ., USSR). Yadern. Fiz., 6: 982-7(Nov. 1967). (In Russian).

By means of the Green functions method, the (t,p) reaction amplitude is formed which takes into account the wave distortion internal structure of the triton and various exchange mechanisms and which allows one to describe the (t,p) reactions at any scattering angles. The corrections to the existing distorted-wave calculations are given. Due to the use of the small-angle approximation and to the transition into the momentum representation, the amplitude of the (t,p) reaction is written in terms of propagators and vertex parts. The investigation of analytical properties and comparison of this amplitude with the Shapiro–Timashev amplitude corresponding to the triangle diagram is performed. It was noted that though these amplitudes are qualitatively close, the quantitative agreement of the Shapiro–Timashev amplitude with the experiment is in general impossible both from the point of view of genealogy and configuration mixing and due to the necessity of considering one more amplitude than the Shapiro–Timashev amplitude includes. (auth)

14098 DETERMINATION OF THE SCATTERING MATRIX ELEMENTS IN PRESENCE OF A THREE-PARTICLE CHANNEL. Lazarev, L. M. Yadern. Fiz., 6: 1073-5(Nov. 1967). (In Russian).

Nuclear reactions with one two-particle (A + a) and one three-particle (1 + 2 + 3) open channels are considered. It is shown that in case of spinless particles the measurements of the differential cross sections of the reactions A(a,a)A and A(a; 1,2)3 are sufficient to reproduce the elastic scattering amplitude. (auth)

14099 CHANCE COINCIDENCE AND DEAD TIME CORRECTIONS IN ϵ/β^+ RATIO DETERMINATIONS USING THE COINCIDENCE METHOD. Vatai, E. ATOMKI (At. Kut. Intez.) Kozlem., 9: 273-6(Oct. 1967).

Formulae for chance coincidence and dead time corrections are given in the case where the ϵ/β^+ ratio is determined by the coincidence method, and coincidences with annihilation quanta ($\beta^+\gamma^{\pm}$) are used for positron counter efficiency calibration. (auth)

14100 KINETIC ENERGY AS A PERTURBATION. II. Gammel, J. L. (Texas A and M Univ., College Station); Rousseau, C. C.; Saylor, D. P.; Wright, R. M. J. Math. Anal. Appl., 20: 229-38(Nov. 1967).

Results of investigations of a previous method for the solution of a difference equation approximation to the one-dimensional Schrödinger equation by perturbation theory with the kinetic energy part of the Hamiltonian taken as the perturbation applied to few- and many-particles problems are given. These problems are much simpler than any of physical interest but are exactly soluble by other methods and thereby provide a test case. These are linear chains of particles of equal mass with neighbors connected by springs. (J.F.P.)

14101 THE S-WAVE PHASE SHIFT FOR A SOFT "HARD-CORE" POTENTIAL. Kuchowicz, B. (Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 643-6(1967).

The standard Schrödinger equation for the two-particle system interacting via a potential of the form $V(r) = De^{-2\alpha(r-r_0)} - 2De^{-\alpha(r-r_0)}$ is applied to obtain an analytical expression for the s-wave phase shift in terms of simple functions. (S.F.L.)

14102 DEFORMED EXCITED STATES IN CLOSED SHELL NUCLEI. Eichler, Joerg; Marumori, Toshio (Univ. of Copenhagen). Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 35: No. 7, 56p(1966).

The approach of G. E. Brown in interpreting the low-lying even-parity states in closed-shell nuclei is discussed, and a refinement is offered which takes into account a collective predisposition in the spherical ground state and treats the cooperation effect of the core for deformations in the excited states in a self-consistent way. In the systematic theory presented for treating the complex ground-state correlations for 2-particle 2-hole excitations, it is shown that these new ground-state correlations describe the collective predisposition of the spherical ground state in closed-shell nuclei to produce deformed excited states. The resulting deformation of the excited states incorporates the deformation of the core. Formal properties of the solutions and their influence on various electromagnetic transitions are discussed. It is now possible to account for the strong collective lowering (with respect to the unperturbed positions) of first excited even-parity states. It is due mainly to the deformation, but is triggered by the residual interaction. Since the excited state with a definite intrinsic deformation properly contains the ground-state correlations, there is no difficulty in simultaneously explaining both the rotational band structure and the E2 transition to the ground state. Although the ground state is spherical and the excited states are deformed, strong electromagnetic transitions may be expected between the rotational band and the ground state. (BBB)

14103 RETARDED INTERACTIONS IN FERMI SYSTEMS. Dover, C. B. (Massachusetts Inst. of Tech., Cambridge); Lemmer, R. H. Contract AT(30-1)-2098. Phys. Rev., 165: 1105-23(Jan. 20, 1968).

The nature of the two-body interactions in many-fermion systems is studied from the viewpoint of meson theory. An exactly soluble model is formulated for the linear coupling of a meson field to fermion density fluctuations, in which meson degrees of freedom are treated exactly, and fermion motion is treated within the domain of the random-phase approximation (RPA). Instability conditions for the RPA ground state are established. More generally, the effective two-body interaction is deduced via a Green's-function technique by eliminating the meson degrees of freedom. This interaction is shown to be frequency-dependent, i.e., retarded in time. The resulting interaction is then applied to the calculation of the Hartree-Fock (HF) field and of the collective modes of the system via a generalized Landau equation. In the HF approximation, one obtains an unambiguous separation of renormalization (self-energy) effects and the nucleon-nucleon interactions themselves, the former reducing to the correct mass renormalization of the nucleon in the static limit. For reasonably small momenta ($p < p_F$), the retardation corrections to the HF field can be characterized by a small parameter $(\epsilon_F/\mu)^2$ (≈0.1 for actual nuclear densities), where ϵ_F = Fermi energy and μ = meson mass. The corrections become more important at high momenta and densities. In the long-wavelength limit, the frequency-dependent corrections to the collective mode energies are found to be of order

$(\omega/\mu)^2$, where ω = collective mode energy. For a static Yukawa interaction, a value $\lambda^2 \approx 5$ (consistent with the usual shell-model values) is found for the neutral scalar coupling constant by requiring that the giant dipole collective state appear at the experimental energy. For pseudoscalar coupling, the usual renormalized coupling constant $f^2/4\pi \approx 0.08$ is shown to yield a "breathing mode" in heavy nuclei consistent with crude estimates based on nuclear compressibilities. (auth)

14104 MODIFICATION OF THE SPECTROSCOPIC FACTOR IN (^{3}He,d) REACTIONS DUE TO THE t . T INTERACTIONS. Tamura, Taro (Oak Ridge National Lab., Tenn.). Phys. Rev., 165: 1123-5(Jan. 20, 1968).

A correction term to the usual distorted-wave Born-approximation amplitude of the (^{3}He,d) reaction is derived by using Lane's t · T interaction. This interaction changes the ^{3}He into t and the target into its analog, and thus gives rise to a (t,d) reaction from this analog channel; the deuteron produced in this way is coherent with the deuteron produced by the straightforward (^{3}He,d) reaction. It is shown that this coreaction term changes the value of the derived spectroscopic factor by an important amount, and makes it agree well, if not completely, with the value predicted by the shell-model calculation. (auth)

14105 PHENOMENOLOGICAL Λ-NUCLEON POTENTIALS FROM S-SHELL HYPERNUCLEI. III. DEPENDENCE ON POTENTIAL SHAPE. Herndon, R. C. (Nova Univ., Fort Lauderdale, Fla.); Tang, Y. C. Phys. Rev., 165: 1093-5(Jan. 20, 1968).

The binding-energy data of the s-shell hypernuclei and the Λ-proton scattering data are analyzed with Λ-nucleon potentials which have a hard core and an attractive part of Yukawa shape. By comparing the results with those obtained in a previous investigation where the attractive part was assumed to be of exponential shape, it is concluded that to analyze these experimental data, the choice of the spatial form for the attractive part is not a critical one. (auth)

14106 EFFECTS OF T VIOLATION IN NUCLEAR REACTIONS. Moldauer, P. A. (Argonne National Lab., Ill.). Phys. Rev., 165: 1136-46(Jan. 20, 1968).

A violation of time-reversal invariance of the nuclear Hamiltonian results in a violation of the reciprocity relation connecting the magnitudes of nuclear reaction cross sections in which initial and final states are interchanged. The development of reaction theory in the absence of T invariance is outlined, and the connection between T violation and reciprocity violation is calculated for the cases of direct reactions, isolated resonances, average compound-nucleus cross sections, and fluctuating cross sections measured with good energy resolution. It is found that in a direct reaction the magnitude of the reciprocity violation is proportional to the matrix elements of the T-odd part of the Hamiltonian connecting different competing residual states, divided by the energy separations of these residual states. In isolated resonances and average cross sections the effect depends entirely on the presence of a competing direct reaction. In fluctuating cross sections the rms value of the reciprocity violation is proportional to the rms absolute value of the matrix elements of the T-odd part of H connecting different "compound states," divided by the geometric mean of the average spacing and the average width of these "compound states." Thus the effect is favored in fluctuating reactions over direction reactions by a factor of the order of the ratio of the mean spacing of residual levels to the geometric mean of the average widths and spacings of compound levels. An additional strong enhancement of the fluctuating effect appears in the presence of competing strongly absorbed channels. Various aspects of possible experimental tests of reciprocity violation are discussed. (auth)

14107 ATTAINMENT OF STATISTICAL EQUILIBRIUM IN EXCITED NUCLEI. Harp, G. D.; Miller, J. M.; Berne, Bruce J. (Columbia Univ., New York). Phys. Rev., 165: 1166-9(Jan. 20, 1968).

The usual interpretation of high-energy nuclear reactions entails a two-step mechanism: a first step, which includes the emission of knock-on particles in an intranuclear cascade generated by the incident particle, followed by the "evaporation" of particles from the residual excited nucleus, which is assumed to be at statistical equilibrium. If the independent-particle model with residual two-body interaction is taken as a description of the residual excited nucleus, the assumption in the second step requires that the nonequilibrium distribution of nucleons and holes that are produced in the fast step approach the equilibrium distribution before more particles leave the nucleus. This requirement has been investigated and shown to be valid by numerically solving a Boltzmann-like master equation for a Fermi-gas system. (auth)

14108 SCATTERING OF PLANE-POLARIZED PHOTONS BY THE GIANT RESONANCES OF NUCLEI. Arenhoevel, Hartmuth (Univ., Frankfurt am Main); Hayward, Evans. Phys. Rev., 165: 1170-4(Jan. 20, 1968).

The cross sections for the electric dipole scattering of plane-polarized photons are expressed in terms of the angular momentum transferred to the nucleus in the two-step scattering process. These scattering cross sections have been evaluated in the dynamic collective model for a number of vibrational nuclei at 15.1 MeV and for a number of deformed nuclei at 11.4 and 15.1 MeV. A sum rule is derived that relates the total scattering cross section for an odd-A nucleus to that of its even-even neighbor. (auth)

14109 SCATTERING APPROACH TO THE N-BODY PROBLEM. Omnes, Roland (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 165: 1265-72(Jan. 20, 1968). (BNL-11732).

A set of integral equations is proposed for the N-particle scattering amplitude. The kernel of these equations depends only upon the scattering amplitude for a lesser number of particles. The equations have a very compact form and reduce to the Faddeev equation in the case of three-particle scattering. Some applications to bound-state collisions and some approximations are discussed to indicate the relevance of these equations in the theory of nuclear reactions and the discussion of the independent-particle model. (auth)

14110 COLLECTIVE MOTION IN THE NUCLEAR SHELL MODEL. IV. ODD-MASS NUCLEI IN THE sd SHELL. Elliott, J. P.; Wilsdon, C. E. (Univ. of Sussex, Brighton, Eng.). Proc. Roy. Soc. (London), Ser. A, 302: 509-28(Jan. 23, 1968).

The U_3 coupling scheme is used as the basis for a survey of the odd nuclei in the sd shell. Energy levels and electromagnetic properties are compared with experiment. In the first half of the shell, $A < 28$, there is agreement, but in the second half the data suggest something much closer to jj coupling. The need for an effective charge also disappears beyond $A = 28$. (auth) (UK)

14111 AVERAGE ENERGY OF BETA SPECTRA. Widman, J. C. (Allen Park Veterans Administration Hospital, Mich.); Mantel, J.; Horwitz, N. H.; Powsner, E. R. Int. J. Appl. Radiat. Isotop., 19: 1-14(Jan. 1968).

The average energy of electron and positron beta spectra was calculated for allowed transitions and unique first-forbidden and unique second-forbidden transitions. Maximum energies up to 5.0 MeV are considered. The results are tabulated and shown graphically. (auth) (UK)

14112 STUDY OF A DIFFRACTION MODEL WITH SURFACE ABSORPTION. Audebert, B.; Meyer, J.; El-Baz, E.; Lafoucriere, J. (Institut de Physique Nucleaire, Lyon). J. Phys. (Paris), 28: 868-70(Nov.-Dec. 1967). (In French).

The diffraction models often explain the processes of elastic scattering in terms of a pure Fraunhoffer diffraction. A model is proposed in which these effects complete the usual scattering term. Some approximations are made in order to test the basic idea. The first results seem good enough to encourage one to build up a more elaborated version of this theory. (auth)

14113 RELATIVE PROBABILITIES OF THE ISOMERIC STATE EXCITATION IN THERMAL NEUTRON RADIATIVE CAPTURE. Malyshev, A. V. Yadern. Fiz., 6: 1174-80(Dec. 1967). (In Russian).

By means of statistical theory, relative probabilities of production of isomeric state in thermal neutron radiative capture are calculated. The calculations are performed considering the distribution of gamma sources in each of the cascades in an attempt to check the dependence of nuclear level density on the total momentum. In the example of eight odd-odd nuclei for which the isomeric ratios differ approximately by 30 times, it is shown that using only a single parameter of the theory (density of one-particle states near the Fermi energy) one has agreement with the experimental data within 50%. (auth)

14114 ON INTENSITY RULES FOR E1 AND M1 TRANSITIONS IN NUCLEI. Grin, Yu. T. Yadern. Fiz., 6: 1181-3(Dec. 1967). (In Russian).

The dependence of the E1 and M1 transition probabilities on the spins of levels is calculated up to terms of the second order for the interaction of the rotation and the internal motion. (auth)

14115 THEORY OF THE DEUTERON-NUCLEUS INTERACTION. Berezhnoi, Yu. A.; Inopin, E. V. Yadern. Fiz., 6: 1197-1202(Dec. 1967). (In Russian).

The deuteron–nucleus interaction resulting in the disintegration of the deuteron is considered as the inelastic scattering of a particle by a nonspherical field in the adiabatic approximation. The

formulas are obtained to describe the angular and energy distributions for the deuteron decay products. (auth)

14116 NUCLEON CLUSTERS IN NUCLEI ^{6}Li, ^{7}Li, AND ^{9}Be FROM THE DATA ON VARIOUS REACTIONS AT HIGH ENERGIES. Kudeyarov, Yu. A.; Neudachin, V. G.; Serebryakov, S. G.; Smirnov, Yu. F. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 6: 1203-14(Dec. 1967). (In Russian).

Experimental data on the elastic and inelastic scattering of fast electrons on the nuclei ^{6}Li, ^{7}Li, ^{9}Be as well as the data on the spectrum of the recoiling α particles in meson (π^-) capture by ^{6}Li and in (p,2p) reactions on this nucleus are analyzed in the framework of the nucleon cluster model. With the data obtained, one is able to estimate the degree of isolation of the clusters in light nuclei; it is found to be substantial for nuclei with the p-shell filled at the start. One is able also to make some conclusions about the shape of the wave function of the mutual motion of the clusters. The method of calculating various form factors in the nucleon cluster model is presented. (auth)

14117 CORRELATION OF NEUTRINO AND γ QUANTA IN ALLOWED CAPTURE OF POLARIZED μ MESON. Bukhvostov, A. P.; Popov, N. P. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 6: 1241-7(Dec. 1967). (In Russian).

The formula for the correlation of neutrino and γ-quanta directions with the muon polarization vector in allowed μ capture with nuclear excitation is obtained. Arbitrary population of levels of meso-atom hyperfine structure is assumed. Possible CP violation in μ capture is taken into account. Correlations in the capture of μ mesons by the nuclei ^{10}B and ^{14}N are estimated. (auth)

14118 APPLICATION OF PERTURBATION THEORY IN INVERSE POWERS OF INTERACTION PARAMETER TO THE THREE-NUCLEON SYSTEM. Filippov, G. F.; Ovcharenko, V. I. (Inst. of Theoretical Physics, Kiev). Yadern. Fiz., 6: 1287-93(Dec. 1967). (In Russian).

An approximate method for the solution of the problem of the bound state of the N-particle system is developed in which the expansion is performed in the inverse powers of the interaction parameter; as the zero approximation, the wave functions of the system with the pair oscillator potential are chosen. The efficiency of the method is illustrated by the example of the calculation of the binding energy of the three-particle system. (auth)

14119 TABLES OF TRANSFORMATION BRACKETS FOR NUCLEAR SHELL-MODEL CALCULATIONS. SECOND EDITION. Brody, T. A.; Moshinsky, M. New York, Gordon and Breach, Science Publishers, 1967. 248p. $16.00 Reference Edition, $9.50 Professional Edition. (In English and Spanish).

An explicit expression was recently defined for transformation brackets that will transform a two-particle wave function expressed in coordinates with respect to the center of the potential well into a sum over wave functions expressed in relative and center-of-mass coordinates of the two nucleons. The transformation brackets can be used to express any matrix element directly in terms of Talmi integrals. Tables of the transformation brackets are presented for all cases of interest in nuclear spectroscopy up to and including the i-shell. (D.C.W.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 12463, 12471, 12475, 12590, 12672, 12673, 12676, 12688, 12691, 12970, 12974, 12978, 12984, 12992, 13035, 13041, 13062, 13900, and 13906.

14120 (AECL–2755) LOCATION OF HEAVY WATER LEAKS IN CANADIAN POWER REACTORS. Dombra, A. H. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1967. 25p. (CONF–670713–10). Dep. CFSTI. CAN $1.00.

From 3rd Meeting of the Reactor Operations Division of the American Nuclear Society, Atlantic City, N. J.

Development of new D_2O recovery and leak detection methods led to a reduction of direct D_2O losses at NPD by about 70%. A brief description of leak monitoring systems and leak location methods used at NPD and Douglas Point is given. Recently introduced leak location methods, among them water-sensitive tapes and paints, are described in more detail. The water-sensitive tapes and paints remain stable at 290°C for over one year, and are unaffected by atmospheric humidity. The active ingredients are yellow strontium chromate and silver sulphate which, in the presence of water or steam, form a deeply coloured silver chromate. Included is a brief review of the experience with the control of heavy water leakage during five years of operations at NPD. It shows that the costs of D_2O upkeep can be maintained within acceptable limits with relatively little effort. (auth)

14121 (AHSB(S)R–138) DATA STORE REQUIREMENTS ARISING OUT OF RELIABILITY ANALYSES. Eames, A. R. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). 1967. 51p. Dep. CFSTI. UK.

Information on the reliability of items of plant is required by the reliability analyst in carrying out safety assessments. This report outlines an example of how such reliability information might be collected, analyzed and stored using computer techniques. (auth)

14122 (ANL–7374) A HYBRID-COMPUTER PROGRAM FOR TRANSIENT TEMPERATURE CALCULATIONS ON TREAT FAST REACTOR SAFETY EXPERIMENTS. Bryant, Lawrence T.; Amiot, Lawrence W.; Dickerman, Charles E.; Stephany, William P. (Argonne National Lab., Ill.). Sept. 1967. Contract W-31-109-eng-38. 38p. Dep. CFSTI.

A detailed description of a hybrid-computer program for temperature calculations in multiregion, axisymmetric, cylindrical reactors. An explanation of the mathematical bases, special features, and input-output format are given; sample problems are included. Temperatures are calculated at node points equally spaced within a region. The hybrid computer consists of a stored-program digital computer with an 8K core memory, linked with an analog computer. The analog computer solves the differential equations resulting from the finite difference approximation to the heat transfer equations; the functions of the digital computer are: parameter input, arithmetic computation of system coefficients, analog potentiometer setting, system check, control and storage and memory. 11 references. (M.L.S.)

14123 (ANL–7380, pp 15–21) SEFOR DEVELOPMENT ACTIIVITIES. Hines, D. P.; Horst, K. M. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation).

Instrument development for SEFOR is outlined. The instrumented fuel assembly is discussed. A typical calibration curve for the high temperature fuel thermocouples is shown; effects of radiation on the calibration are shown. An in-core magnetic flowmeter is described; the transient power detector is discussed. (M.L.S.)

14124 (ANL–7380, pp 29–36) FERMI PROCESS INSTRUMENTATION. Scott, Clyde C. (Atomic Power Development Associates, Inc., Detroit, Mich.).

Moore Products Company Model 15 pressure sensors are installed in the reactor vessel, the pump tanks in the primary sodium system, and the steam generators, for measuring sodium levels. Performance of the detectors has been less than completely satisfactory but, with some maintenance, can be operated. Accuracy of measurements is estimated to be approximately ±5%. Taylor Instruments Company NaK-filled pressure sensors are used to measure primary-pump discharge pressures, blanket-plenum pressures, and levels in the overflow tank and one sodium-storage tank. Performance of the units has been satisfactory. EM flowmeters are used in the three primary and three secondary loops. Difficulties have been experienced in obtaining calibration curves for the flowmeters in the primary loops. The outputs from the 14-in. flowmeters are quite nonlinear; the nonlinearities result from the small ratios of pole faces to pipe diameters. The performance of the thermocouples and platinum resistance thermometers in the primary system has been satisfactory. An isothermal system calibration approximately four years after installation indicated that the outputs of the thermocouples were within the ISA standards for standard grade iron-constantan thermocouples. (auth)

14125 (ANL–7380, pp 40–2) SCTI SODIUM INSTRUMENT OPERATING EXPERIENCE. Turner, G. E. (Atomics International, Canoga Park, Calif.).

Use of permanent magnet flowmeters in SCTI is discussed. Performance of NaK-filled pressure transmitters is evaluated. Measurements of sodium level using induction-coil, bubbler, radiation, and placer-float gages is outlined. (M.L.S.)

14126 (ANL–7380, pp 43–6) TEMPERATURE PROTECTIVE CIRCUITS FOR THE HNPF FUEL-CHANNEL EXIT. Dunsmore, C. L. (Atomics International, Canoga Park, Calif.).

The HNPF plant protective system includes circuits with the function of precluding unsafe high temperature and sustained fast changes in fuel-channel coolant-exit temperatures, either in the increasing or decreasing direction. The development of the fuel-channel-exit high-temperature and rate-change-of-temperature circuits resulted in a transistorized system of plug-in components of high reliability. The circuits have been designed, where possible, for fail-safe operation in case of component malfunction, and for ease of maintenance and calibration. In addition to providing shutdown or scram signals, these circuits also provide setback and alarm signals. The set points for scram, setback, and alarm are each independently adjustable. These circuits monitor an iron-constantan thermo-couple located at the outlet of a fuel cluster in the reactor. In the actual protective system, three identical circuits are used in a two-out-of-three coincidence arrangement to enhance the overall reliability. (auth)

14127 (ANL–7380, pp 63–4) MINIATURIZED PRESSURE SENSOR FOR LMFBR ENVIRONMENT. Kinzer, J. E. (Atomics International, Canoga Park, Calif.).

A pressure sensor small enough to be inserted into the end caps of clad fuel specimens has been developed and tested. The ADIT (Advanced Development Irradiation Techniques) pressure sensor has been used to obtain pressure measurements during irradiation for long periods of time. By minimizing the sensitivity to flux and temperature and attempting to make the device as small as possible, close proximity to the pressure source can be achieved. The ADIT pressure sensor is similar in operation and principle to that of the Booth–Cromer type. The active housing is 0.35 in. in diameter and 0.4 in. long. The overall length, which includes provision for pressure connections, is 0.65 in. Sensors have been calibrated up to 1600°F with no detrimental effects observed. They have performed well in thermal-reactor irradiation experiments while subjected to exposures of 2×10^{20} nvt fast and 10^{21} nvt thermal. Pressures of 65 psia were accurately measured in out-of-pile sodium loop tests operated at 500–1100°F. (auth)

14128 (ANL–7380, pp 140–5) ALL-SOLID IN-CORE POWER MONITORS FOR LMBFR SERVICE. Lewis, R. H. (Babcock and Wilcox Co., Lynchburg, Va.).

Development of all-solid in-core power monitors for sodium cooled fast reactors is discussed. Results of in-core operation in a PWR of these rhodium detectors are shown. A comparison of estimates of signal and background current for a PWR and LMBFR is tabulated. 10 references. (M.L.S.)

14129 (APDA–212) QUARTERLY TECHNICAL PROGRESS REPORT ON AEC-SPONSORED ACTIVITIES, JUNE 15–SEPTEMBER 15, 1967. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 92p. Dep. CFSTI.

REACTORS, LIQUID METAL-COOLED— steam generators for, effects of sodium-water reactions in; sodium coolant for, rhometers for impurity measurement in; sodium coolant for, oxygen meter for impurity measurements in
BOILERS— sodium-water reactions in LMFBR, effects of
SODIUM— reactions with water, analysis of corrosion products from; flow of liquid, effects on tube wastage of; impurities in, response of rhometer to; oxygen impurities in, response of meter for measuring; plugging meter for liquid, analysis using; hydrogen solubility in metallic
WATER— reactions with sodium, analysis of corrosion products from

TUBES—wastage of, effects of liquid sodium flow on
RHOMETERS—response to sodium impurities
OXYGEN—impurities in sodium, response of meter for measuring
ULTRASONIC INSPECTION—transceiver tube for liquid sodium, design of
TRANSDUCERS—design of transceiver
FAST TEST REACTOR—fuel meltdown analyses for, discussion of calculations of
URANIUM ISOTOPES U-238—neutron cross section evaluation for, total inelastic
CHROMIUM ISOTOPES Cr-52—neutron cross section for, inelastic scattering
IRON—isotopes of, resolved resonance parameters for
NEUTRON CROSS SECTIONS—evaluation of uranium-238 and chromium-52 (M.L.S.)

14130 (APDA-NTS-12) MEASUREMENT OF SOME REACTIVITY EFFECTS IN THE ENRICO FERMI REACTOR. Seeley, G. T.; Ball, G. L.; Branyan, C. E.; Horne, R. E.; Mueller, R. E.; Segal, B. M.; Wilber, H. A. (Atomic Power Development Associates, Inc., Detroit, Mich.). Nov. 1967. 76p.

Various nuclear tests are described which followed initial criticality of the Fermi fast breeder reactor. Measurements were made of the reactivity effects of the permanent neutron source, retractable neutron source, temporary instrument thimble, variation in flow rate of the primary coolant, and variation in pressure of cover gas in the primary system. Each test is reported separately and includes tabulated and graphical test data and discussions of purpose, apparatus and equipment, reactor plant conditions, measurements, experimental results and analysis, and conclusions. (auth)

14131 (APDA-NTS-14) TRANSFER FUNCTIONS FROM REACTIVITY PULSES GENERATED BY THE REGULATING ROD; ENRICO FERMI REACTOR. Batch, M. L.; Klickman, A. E. (Atomic Power Development Associates, Inc., Detroit, Mich.). Dec. 1967. 31p.

The measurement of reactor power and temperature responses to reactivity pulses generated by a single, trapezoidal movement of the regulating rod is discussed. Data obtained at three power levels are reduced by Fourier analysis of their time derivatives. Results are presented in terms of transfer functions between reactivity and power and between power and outlet temperatures. The advantages and disadvantages of this technique with respect to an alternate oscillator rod technique are examined. (auth)

14132 (BMI-X-10213) FISSION-PRODUCT DEPOSITION AND ITS ENHANCEMENT UNDER REACTOR ACCIDENT CONDITIONS. Quarterly Progress Report, July–September 1967. Genco, Joseph M.; Berry, David A.; Berry, Warren E.; Rosenberg, Harvey S.; Cremeans, George E.; Morrison, David L. (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1967. Contract W-7405-eng-92. 62p. (EURAEC-1968). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

IODIDES—deposition on prefilmed Zircaloy-4 and Type 304 stainless steel
STAINLESS STEEL—iodide deposition on prefilmed Type 304
ZIRCALOY-4—iodide deposition on prefilmed
IODINE—deposition in reactor primary systems; sorption by painted surfaces, analytical model for describing
REACTORS, WATER-MODERATED—cooling systems for, iodine deposition in primary
COATINGS—iodine deposition on reactor containment system, effects of temperature on liquid-phase; interactions between containment spray solutions and reactor containment system; methyl iodide deposition on reactor containment system
REACTOR CONTAINMENT SYSTEMS—coatings for, effects of temperature and liquid-phase iodine deposition on; spray solutions for, interactions between coatings and; coatings for, methyl iodide deposition on
METHANE—IODO, deposition on various reactor containment system coatings (M.L.S.)

14133 (DLCS-5000367) SHIPPINGPORT ATOMIC POWER STATION THIRD QUARTERLY OPERATING REPORT, 1967. (Duquesne Light Co., Shippingport, Pa. Power Stations Dept.). Contract AT(11-1)-292. 22p. Dep. CFSTI.

An operations history of Shippingport is given for the period July 1–September 30, 1967. A total summary of Core 2 station performance is presented. Reactor and turbine plant chemistry is discussed; coolant system chemistry is tabulated for operating and shutdown conditions. Fission product analysis of Core 2 Seed 1 is given; operating and nonoperating boiler water chemistry is tabulated. Maintenance and refueling preparations are outlined. The on-line test program is discussed briefly. (M.L.S.)

14134 (EUR-3732) RESEARCH PROGRAM INTEGRATIVE OF THE ENEL PROGRAM ON THE TRINO VERCELLESE REACTOR. Annual Report, June 1966–May 1967. (FIAT, Turin (Italy). Sezione Energia Nucleare). Jan. 1968. Contract 098-66-6 TEEI. 58p. Dep.

The principal research progress on a program for the development of closed cycle water reactor technology is presented. Operational data from the Trino reactor was selected for theoretical evaluation of reactivity balances and long term reactivity changes. A calculational method was developed which consists essentially of evaluating the nuclear constants needed to analyze the fuel burnup, power distributions, and the reactivity coefficients. The temperature-B and X reactivity coefficients at startup and at 7000 MWd/MTU were calculated and compared to measured data. The variation of the critical B concentration with fuel burnup and the correlation between fuel mean effective temperature and core power were analyzed. Power density distributions obtained from aeroball runs performed during the Trino reactor first cycle were analyzed and compared with theoretical results. Coolant flow redistribution within the Trino reactor core area and in a fuel element was calculated using both closed and open channel models for adiabatic and non-adiabatic cases. The Trino reactor core safe operating limits and vertical steam generator instabilities were analyzed. An analysis of the control and safety system performance was evaluated. (H.D.R.)

14135 (EURAEC-1958) RESEARCH PROGRAM FOR THE GARIGLIANO NUCLEAR PLANT. Report No. 14, July 1–October 31, 1967. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Nov. 1, 1967. Contract 010-63-11-RD-I. 10p. (EUR-3767). Dep.

Work Performed under United States–Euratom Joint Research and Development Program.

The preparation of computer codes for analysing foil irradiation data is discussed. Simulation of core potential is described; reactor stability analyses are discussed. (M.L.S.)

14136 (GA-8065) SHIELDING STUDIES FOR THE PUBLIC SERVICE COMPANY OF COLORADO HTGR. Engholm, B. A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 24, 1967. Contract AT(04-3)-633. 38p. (CONF-670932-4). Dep. CFSTI.

From International Conference on the Physics Problems of Reactor Shielding, Harwell, England.

Radiation-shielding methods used by General Atomic in the design of a 330-MW(e) HTGR power plant for the Public Service Company of Colorado are described. Neutron fluxes outside the reactor core are calculated by a combination of the DTF-IV transport code and the GAZE diffusion code. For preliminary shielding calculations and parametric studies, a more rapid neutron-shielding code is available, based in part on the Spinney method. γ calculations are handled either by transport theory or by General Atomic's new PATH code, which is based on exponential attenuation from source point to dose point, adjusted by appropriate buildup factors. Duct streaming is treated by a variety of methods, including Monte Carlo techniques and a combination albedo and graphical approach. The MUSCAT code has been written to treat multiple scattering of particles in spherical or cylindrical annuli, such as the space between the reactor and pressure vessel. An extensive calculational program is under way to generate gamma buildup factors for homogeneous materials not considered by Goldstein and Wilkins and for heterogeneous media such as alternating layers. Exploratory transport-theory results agree well with moments-method data and experimental measurements. Initial shielding measurements performed on the Peach Bottom HTGR are in satisfactory agreement with calculated values. (auth)

14137 (GEAP-5561) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Fourteenth Quarterly Report, August–October 1967. Pflasterer, G. R. (comp.) (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Nov. 1967. Contract AT(04-3)-540. 29p. Dep. CFSTI.

Results of SEFOR ion chamber and amplifier testing in Super-Kukla are shown; these transient tests are compared with static tests. Transient test conditions are given for SEFOR and Super-Kukla. Acceptance tests and results of the data acquisition system are detailed. Use of a reactivity computer for SEFOR is evaluated. Administrative information on fuel handling, fuel fabrication, plant construction, and training is given. (M.L.S.)

14138 (NAA-SR-Memo-12485) BOILING LIQUID METALS AND TWO-PHASE FLOW INVESTIGATIONS. Logan, D.; Randall, R. L.; Baroczy, C. J.; Landoni, J. A. (Atomics International, Canoga Park, Calif.). June 1, 1967. Contract AT(04-3)-701. 34p. (CONF-670916-3). Dep. CFSTI.

From International Conference on the Safety of Fast Reactors, Aix-en-Provence, France.

The results of investigations in the areas of boiling liquid metals and two-phase flow are described; their significance in the design of Liquid Metal Fast Breeder Reactors is discussed. The work includes: development of a reliable, consistent method for detecting boiling in liquid metals, development of high flux heaters required in the accurate simulation of reactor cores, analytical methods for predicting transient boiling and flow in a channel, and methods for predicting the two-phase flow characteristics of all fluids, including liquid metals. 22 references. (auth)

14139 (NYO-3906-1) ULTRASONIC THERMOMETRY IN LMFBR SYSTEMS. Quarterly Progress Report No. 1, October 1–December 31, 1967. Fam, S.; Lynnworth, L. C.; Carnevale, E. H. (Parametrics, Inc., Waltham, Mass.). Jan. 29, 1968. Contract AT(30-1)-3906. 21p. Dep. CFSTI.

An ultrasonic thermometry system is being developed to automatically determine the fuel, cladding, and coolant temperatures in liquid metal cooled fast reactors. Maximum expected temperatures are 2000°F for the coolant and 5000°F for the fuel. Likely sensor materials are W, Re, Ta and Mo, for use over the whole temperature range, and possibly certain stainless steels, for use to 1600°F. Velocity and attenuation have been measured in short W and Re sensors to 5000°F, and in a 50 ft W lead-in, 20 ft of which were heated to 2000°F. Effects of coiling and simulated Na immersion were also determined. (auth)

14140 (ORNL-TM-2111) MSRE DESIGN AND OPERATIONS REPORT. PART V-A. SAFETY ANALYSIS OF OPERATION WITH ^{233}U. Haubenreich, P. N.; Engel, J. R.; Gabbard, C. H.; Guymon, R. H.; Prince, B. E. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 80p. Dep. CFSTI.

MOLTEN SALT REACTOR EXPERIMENT—fuel salts for, description of; piping and containers in, use of Hastelloy-N for; containment system for, safety of; operations history of, total; fuel salts for, loading of uranium-233; fuels for, neutronic characteristics with uranium-233 and uranium-235; safety analyses for uranium-233 fueled; uranium resuspension incident in, analysis of; response to load changes

REACTOR FUELS—composition of MSRE, description of

HASTELLOY N—mechanical properties of irradiated

REACTOR CONTROL ELEMENTS—reactivity worth of MSRE, effects of use of uranium-233 and uranium-235 fuels on

REACTIVITY—worth of MSRE control rods, calculated effects of use of uranium-233 and uranium-235 fuels on

REACTOR CONTAINMENT SYSTEMS—leakage rates for MSRE

URANIUM ISOTOPES U-233—production for MSRE

REACTOR SAFETY—analysis of MSRE with uranium-233 fuel salts (M.L.S.)

14141 (PRDC-EF-51) POWER REACTOR DEVELOPMENT COMPANY, ENRICO FERMI ATOMIC POWER PLANT REPORT FOR NOVEMBER 1967. (Power Reactor Development Co., Detroit, Mich.). 7p. Dep. CFSTI.

Brief summaries of the operations, health physics, maintenance, modifications, and non-nuclear test program activities are presented. (H.D.R.)

14142 (TID-8200(17th Rev.)) NUCLEAR REACTORS BUILT, BEING BUILT, OR PLANNED IN THE UNITED STATES AS OF DECEMBER 31, 1967. (Office of the Assistant General Manager for Reactors (AEC), Washington, D. C.). 34p. Dep. CFSTI.

Information is tabulated on name, owner, location, principal contractor, type, power, and operating dates for United States facilities capable of sustaining a nuclear chain reaction. The reactors are categorized by primary function, including civilian reactors, production reactors, military reactors, reactors for export, and critical assembly facilities. (H.D.R.)

14143 (UNC-5172) CARBON METER FOR SODIUM. Quarterly Progress Report, July 1–September 30, 1966. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Mar. 15, 1967. Contract AT(30-1)-3665. 28p. Dep. CFSTI.

Thirty-two probe tests were completed in static high-C Na. Substitution of water vapor H_2–Ar_2 mixtures for pure H_2 as the probe gas greatly increased the C flux through the probe wall, eliminated carbon buildup in the wall, and reduced the H_2 permeation rate into the Na. Quantitative catalytic conversion of the CO formed in the probe gas to CH_4 was shown to be feasible, permitting use of the highly sensitive flame ionization detector to measure continuously the C flux through the probe wall. Results indicate that the C meter probe will be pure Fe, ~10-mils thick, operated at ~1400°F. (auth)

14144 (UNC-5180) CARBON METER FOR SODIUM. Quarterly Progress Report, October 1–December 31, 1966. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). June 15, 1967. Contract AT(30-1)-3665. 44p. Dep. CFSTI.

The carbon meter response to insertion and removal of carburized iron tabs in a sodium thermal convection loop was measured. A flame ionization detector was selected, evaluated, and found to be satisfactory for the C meter gas analysis system with slight modification. A standard probe gas composition of 0.5% water vapor, 5% H_2, balance Ar was selected on the basis of additional static pot tests. Considerable evidence was developed indicating that H_2 reacts with active C in Na at 1400°F to form hydrocarbons and thereby depresses the C activity. One probe was examined after 1446 hr of operation in high C Na at 1400°F. (auth)

14145 (UNC-5181) CARBON METER FOR SODIUM. Quarterly Progress Report, January 1–March 31, 1967. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). June 30, 1967. Contract AT(30-1)-3665. 44p. Dep. CFSTI.

A series of thermal convection loop tests demonstrated a definite correlation between the carburization rate of Fe and stainless steel tabs and the C meter reading of the Na to which they were exposed. Additions of carbon-bearing materials in both loop and capsule tests showed that O_2 greatly enhances the carburizing effectiveness of elemental C in Na at 1400°F. Unstable carbides, such as of Fe and Na, are able to create a significant carburizing potential in Na without addition of O_2. Use of a second thermal convection loop awaits completion of instrumentation for measuring the performance of a H_2 removal system. Fe containing 1% Ni transmits as high a C flux as Armco iron but exhibits considerable grain growth. Fe alloys with 18 and 30% Ni are not as attractive as probe material as pure Ni. A standardized side loop is being developed to provide temperature control of the probe as part of the C meter package. (auth)

14146 (UNC-5187) CARBON METER FOR SODIUM. Quarterly Progress Report, April 1–June 30, 1967. Caplinger, W. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Aug. 31, 1967. Contract AT(30-1)-3665. 26p. Dep. CFSTI.

A model was developed which quantitatively correlates the carbon meter reading with the short-time carburization of 304 stainless steel in Na. The C meter flux corresponding to that C activity necessary to initiate α to γ transformation in Fe at 1400°F has been bracketed. Tests in capsules have confirmed the static pot test observations that the carburizing potential of graphite in Na is strong adjacent to the source but falls off sharply in the surrounding few millimeters. O_2 appears to enhance the carburizing effectiveness of C and C-bearing compounds, although the effect is less pronounced for the latter. Measurements of H_2 leakage rates from probes are under way. A prototype gas supply and analysis console has been assembled and is currently undergoing checkout. (auth)

14147 (WAPD-MRP-122) PRESSURIZED WATER REACTOR (PWR) PROJECT. Technical Progress Report, July 22–October 20, 1967. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Contract AT(11-1)-Gen-14. 68p. Dep. CFSTI.

SHIPPINGPORT PRESSURIZED-WATER REACTOR—operation history of; steam generators for, wall thinning surveillance of; core for, permissible power levels for extended life of; core 1 for, examination of Inconel-X blanket holding springs for; refueling equipment for, description of

ALUMINUM—corrosion testing of, use of potassium tetraborate for

XENON—burnout in Shippingport Core 2 Seed 1, measurements on; oscillations in Shippingport Core 2 Seed 1, use of flux wires for determining

NEUTRONS—flux determinations in Shippingport Core 2 Seed 1, wire irradiations for

REACTOR FUEL ELEMENTS—radiation effects on Shippingport Core 2 Seed 2 plate-type; temperature analyses for Shippingport Core 2 Seed 2, fuel plate surface

REACTOR FUELS—development of enriched uranium oxide (UO_2) ceramic, for use in pressurized water reactors

REACTORS, PRESSURIZED-WATER—fuels for, development of enriched uranium oxide (UO_2) ceramic (M.L.S.)

14148 (JPRS-43842) ATOMIC POWER ENGINEERING. Pozdnyakov, B. S. Translated from Priroda, 57: No. 10, 28-39(1967). 23p. CFSTI.

The development and growth of nuclear power in the Soviet Union is reviewed from the time of the first reactor operation in 1946 to present efforts towards fast breeder power reactors. Future prospects for nuclear power plant construction are tabulated, and possible power conversion methods which do not utilize the steam cycle are discussed. (H.D.R.)

14149 (ORNL-tr-1764) ATOMIC ENERGY COMMISSARIAT: FAST NEUTRONS. Report of Activities of 1st Trimester 1967. Translated by Gregory L. Boisvert (Oak Ridge National Lab., Tenn.), from a French Report. 96p. Dep. CFSTI.

Malfunctions, prior to startup, of the Rapsodie primary pumps are discussed; subsequent primary loop testing is described. Control rod testing is outlined. Loading operations and approach-to-critical are discussed; criticality measurements are described. Low power measurements are detailed. Approach-to-power reactor dynamics are shown. Basic neutron physics measurements made in the HARMONIE critical assembly are outlined. Criticality studies in the plutonium fueled MASURCA critical assembly are described. Calibration of MASURCA control rods is described. Calculational and model studies of the Phenix core are outlined. Research on fuels and irradiation of prototype oxide, carbides and nitrides is discussed. Results of mechanical properties studies on cladding materials are presented; radiation effects studies are summarized. Sodium technology studies are outlined. Results of calculations of pressures due to sodium-water reactions are shown. Reactor Safety tests are summarized. (M.L.S.)

14150 (WAPD-Trans-84) BEHAVIOR OF RADIOACTIVE IODINE. Hattori, Sadao. Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from Nippon Genshiryoku Gakkaishi, 8: 656-9(1966). 11p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Data from a selection of papers on the quantitative evaluation of the physical and chemical behavior of fission product iodine released into single or mixed phases of water, steam, and air in a nuclear power plant are reviewed. Distribution of iodine between air and water phases and iodine adsorption at the wall of the system are examined for accident conditions. Iodine behavior under normal operating conditions is also discussed. (H.D.R.)

14151 REQUIREMENTS FOR NUCLEAR POWER REACTOR SITING. Itakura, Tetsuro; Hashimoto, Tatsuya (Japan Atomic Power Co., Tokyo). Hoken Butsuri, 2: 108-15(Mar. 1967). (In Japanese).

The outline of the Site Criteria in USA and UK and "A Guide in Reactor Site Evaluation" in Japan and the detailed and general requirements with respect to the choice of Nuclear Power Reactor Site, showing examples of siting four Nuclear Power Stations in Japan together with safety analysis, are presented. (auth) (NSA of Japan)

14152 CHALLENGE OF ATOMIC ENERGY. Searby, P. J. Inst. Petrol. Rev., 21: 119-24(1967).

Predictions of nuclear technology progress made 10 years ago are re-examined. During the 10 years it has become evident that there is no immediate shortage of fossil fuels, economics of scale and other factors have reduced costs of generation, the Magnox and Stage 2 reactor programmes have been modified, an advanced gas-cooled reactor is being built at Dungeness "B", and the major development has been on the fast reactor, for which a prototype is being built at Dounreay for operation in 1971. (auth)

14153 FACTORS AFFECTING COSTS OF EXPORT NUCLEAR POWER STATIONS. Bainbridge, G. R. (United Kingdom Atomic Energy Authority, Harwell, Eng.); Pashley, D.; Rowlands, D. T. H.; Wagstaff, C. V. Atom, No. 134, 312-20 (Dec. 1967).

Factors affecting export of nuclear power plants from Great Britain are delineated. These factors are broken down into five major areas: factors affecting prime cost, additional factors in contractor's costs, additional factors in customer's costs, factors affecting operation, and total cost comparison. Each area is discussed; the areas are summarized in outline form. (M.L.S.)

14154 INTERCRYSTALLINE STRESS CORROSION CRACKING OF INCONEL 600 INSPECTION TUBES IN THE AGESTA REACTOR. Gronwall, B.; Ljungberg, L.; Hubner, W.; Stuart, W. (Aktiebolaget Atomenergi, Stockholm). Nucl. Eng. Design, 6: 383-90(1967).

When the Ågesta reactor was to be started up after the regular summer shut-down in 1964, intercrystalline stress corrosion cracking was observed in three so-called inspection tubes of Inconel 600 in the reactor vessel. The cracks developed on the outside surface of tubes which were exposed to 217°C light water containing normally 1–4 ppM LiOH or KOH and only small amounts of oxygen and chloride. These solutes may have enriched in crevices at which most of the cracking occurred. Other factors which are thought to have contributed to the cracking are tensile stresses of the order of the 0.2% offset yield strength, built up during shop welding, and a relatively high carbon content of the alloy, 0.08%, giving rise to heavy precipitation of carbides, intergranularly as well as in the interior of the grains. The tube material had a yield strength higher than normally occurring in annealed material. Irradiation and surface contamination were found to be of no importance. The observations seem to agree with previously published observations of intercrystalline stress corrosion cracking in Inconel 600. Attempts to reproduce the failure in the laboratory have not yielded cracks. The failures encountered show that Inconel 600 under certain conditions may be susceptible to intercrystalline stress corrosion cracking in alkaline high-temperature water. It remains to be shown whether a satisfactory performance of Inconel 600 for long operating periods can be obtained under similar conditions in water-cooled reactors by proper manufacturing control and judicious design, omitting high stresses and crevices. (auth)

14155 HEAT TRANSFER IN WATER-COOLED NUCLEAR REACTORS. Tong, L. S. (Westinghouse Electric Corp., Pittsburgh). Nucl. Eng. Design, 6: 301-24(1967).

A nuclear power reactor is a thermal machine. Its service and economic value depend strongly on thermal performance of the fuel and coolant in the core. Some parameters indicative of the core thermal performance are the fuel surface heat flux, the coolant enthalpy rise, the fuel rod linear power rate and the fuel specific power. The high thermal ratings of these parameters can be achieved only through adequate heat transfer mechanisms and capabilities within the fuel rod and at the clad-water interface. The evaluation of core thermal performance, and the prediction of adequate heat transfer mechanisms and capabilities are examined. 30 references. (auth)

14156 EVOLUTION OF MEASURING EQUIPMENT IN FRENCH REACTORS. Arnaud, M. Atompraxis, 13: 534-7 (1967). (In German).

The evolution of the French measuring equipment, as regards the control of reactors, has developed in two parallel directions: evolution as to the methods used (for instance as to the automatic control, the extension of the measuring ranges, and the measuring of reactivity); evolution of technology regarding the means of measurement leading to the use of semi-conductors and a functional design of the material. (auth)

14157 CONDITIONS FOR SELECTION OF THE SITE OF ATOMIC POWER PLANTS. Itakura, Tetsuro; Moriyama, Fumihiko (Japan Atomic Power Co.). Genshiryoku Kogyo, 13: No. 4, 33-6(Apr. 1967). (In Japanese).

The site for an atomic power plant must be selected, taking the two major requirements into consideration: the requirement of nuclear safety due to the possibility of dispersion of radioactive materials, and the requirement of economy as a commercial power plant. Discussions concerning power plant siting includes: site criteria; conditions for selection of the site such as the area of a site and nonhabitation zone, population distribution in the surrounding area and low-population zone, geology, hydrography, and meteorology; and geographical conditions such as the position in the surrounding power-distribution network, and means of power transport. (NSA of Japan)

14158 CONTROL OF THE OFF-GASES AND ITS PROBLEMS IN JPDR. Mochizuki, Keiichi (Japan Atomic Energy Research Inst.); Makino, Kiyoshi. Genshiryoku Kogyo, 13: No. 5, 27-32 (May 1967). (In Japanese).

The off-gases of JPDR (Japan Power Demonstration Reactor) include hydrogen and nitrogen (radioactive) in the gas after the main condenser, argon-41 from argon in the air, and fission-product gases (Kr, Xe, etc.) when the fuel is ruptured. Although nonradioactive, the hydrogen has the danger of burning and explosion in the piping. It is, therefore, necessary to control it, especially in the JPDR where off-gas storage tanks are incorporated. For all other (radioactive) nuclides, their environmental control, including within the plant, is required. The routine operation of off-gas systems thus includes the control of hydrogen and of radioactive gases. The control methods and problems in coping with the two are described in the following sections: treatment of the hydrogen (formation of hydrogen, measurement of hydrogen, reactions between hydrogen and oxygen, and the hydrogen treatment system); and treatment of the radioactivities (calibration of monitors, the set values of alarms, identification of nuclides, filters, problems in the monitoring pipes, detectors for monitoring, radionuclides in the off-gases, and off-gas storage tanks). (NSA of Japan)

14159 DESIGN AND CONSTRUCTION OF THE TOKAI POWER STATION. Asada, Chuichi. (Japan Atomic Power Co.). Denryoku, 50: No. 12, 43-50(Nov. 1966). (In Japanese).

The Tokai power station in Tokai-mura, Ibaraki-ken, the first commercial atomic power station in Japan, employing an advanced Calder Hall type reactor (natural uranium, graphite moderated and

gas cooled), has been introduced into Japan from England, with GEC as the main contractor. In introduction of atomic power stations into Japan, there are two major points to be considered: the atomic power station has a possibility of causing radiation hazards in the surrounding area, and Japan is the only country in the world to have suffered the devastation of an atomic bomb; and Japan is one of the outstanding countries noted for earthquakes, and for such a peculiar structure as the atomic power station, exhaustive studies must be made on its anti-earthquake construction. In the present article, problems encountered in the introduction of the Tokai power station, the measures taken to resolve them, and difficulties involved in their solution are described with emphasis on the anti-earthquake design of the reactor core and the emergency reactor shut-down mechanism. (NSA of Japan)

14160 TREATMENT OF NEUTRON TRANSPORT IN NUCLEAR REACTORS ACCORDING TO THE KIKUCHI METHODS. Helmis, G. (Institut fuer Magnetohydrodynamik, Jena, Ger.). Kernenergie, 10: 261-5(Sept. 1967). (In German).

The generalization of Kikuchi's theory of irreversible processes allows neutron transport in nuclear reactors to be treated as an irreversible process from the general physical point of view which takes into account both steady state and neutron fluctuations for non-equilibrium thermodynamics. The calculations are presented for the diffusion approximation, and differential and integral path probabilities are calculated for neutron fluctuations in the reactor. (auth)

14161 ECONOMIC INDICATORS OF HWR AND LWR TYPE NUCLEAR POWER STATION FUEL CYCLES. Mojovic, Ljubomir; Ostojic, Miodrag Nukl. Energ., 4: 6-11(1967). (In Slavic).

Economic aspects of fuel fabrication plants, relative to nuclear power station fuel cycles, are discussed. Fuel cycle costs relative to technological advances, demand, and utilization are considered. 33 references. (TSS)

14162 MEASURED INTENSITY DISTRIBUTIONS OF NEUTRONS AND γ-RADIATION OF A PLANE PARALLEL BEAM AND RELAXATION LENGTHS AS FUNCTIONS OF THE VOLUME PERCENTAGE OF THE METAL COMPONENT IN THE SHIELD. Thuro, G.; Heske, M.; Richter, G.; Schnier, C.; Thuro, I. (Institut fuer Reaktorphysik, Geesthacht, Ger.). Atomkernenergie, 12: 409-14(1967). (In German).

The relative contributions of thermal, epithermal and fast neutrons and of γ-radiation to the total biological dose rate of a plane monodirectional beam have been found for 30 shield compositions from measurements at a limited monodirectional beam of a nuclear reactor beam-hole. The shields are composed of combinations of water, steel, lead, polyethylene or concrete. Relaxation lengths of the mentioned radiation groups in quasi-homogeneous shields have been found from measured intensity distributions. From this the optimum volume percentages have been found. (auth)

14163 FUTURE OF HEAVY WATER REACTORS. Margen, P. H. (Aktiebolaget Atomenergi, Stockholm). Tek. Tidskr., 98: 19-22(1968). (In Swedish).

Some of the papers read at an IAEA symposium on heavy water reactors held in Vienna, Sept. 11–15, 1967, are reviewed. The operational experiences, the economics, the designs in progress, and the long-term planning of heavy water reactors are discussed. It is concluded that this type of reactor is a valuable complement to the light water reactor and the fast breeder. (Sweden)

14164 SIGNIFICANCE OF THE D_2O NATURAL URANIUM REACTOR IN NUCLEAR POWER STATION TECHNOLOGY. Ziegler, A. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech., 12: 530-4(Nov. 1967). (In German).

The efforts in development of nuclear energy are reviewed. Installed nuclear power in Germany is shown as a function of time. Specific costs are compared for light water moderated and heavy water moderated reactors; each cost factor is then discussed. (M.L.S.)

14165 PRODUCTION OF A PROTOTYPE FUEL ELEMENT FOR THE HDR. Beckmann, G.; Ruth, H.; Hoechel, J. (Allgemeine Elektricitaets-Gesellschaft Telefunken, Grosswelzheim, Ger.). Atomwirt., Atomtech., 12: 520-4(Nov. 1967). (In German).

A description of the prototype fuel element for the superheated steam reactor, Grosswelzheim, is given. Production is discussed; assembly of the fuel rods into bundles is discussed. (M.L.S.)

14166 ENERGY SPECTRUM OF FAST NEUTRONS SLOWING DOWN FROM A FISSION SOURCE IN A HOMOGENEOUS MEDIUM. Murley, T. E. (Westinghouse Advanced Reactors Div., Madison, Pa.); Kaplan, I. Nucl. Sci. Eng., 31: 207-14(1968).

A method is presented for calculating the energy spectrum of fission neutrons slowing down in a homogeneous medium of arbitrary composition. The integral equation for $\phi(E)$ is solved by an iterative method, yielding a sum of partial spectra which are then summed to obtain a very simple expression for the slowing down spectrum. The effects of absorption and inelastic scattering are accounted for in an approximate manner. The fundamental-mode spectrum for a typical fast-reactor composition was calculated by this method, and the results agree favorably with the central spectrum from a 26-group diffusion calculation. A further application is given for using this method to generate weighting spectra for computing average multigroup cross sections. 14 references. (auth)

14167 TSURUGA ATOMIC POWER STATION, AND PROBLEMS IN THE POWER STATION PIPING. Kimura, Isamu (Japan Atomic Power Co., Tokyo). Haikan Gijutsu, 9: 49-64 (Feb. 1967). (In Japanese).

Construction is in progress on the Tsuruga atomic power station. The power generating plant with 322,000 Kw_e was purchased from G.E. of the United States. The power reactor employed is a direct-cycle, forced-circulation, boiling-water reactor, fueled with low-enriched uranium and moderated and cooled by light water. Concerning problems in the power-station piping, a description is made of the selection of pipe materials anti-earthquake design, and counter-measures for leaks in pumps and piping. (NSA of Japan)

14168 THE TREND OF NUCLEAR POWER GENERATION IN JAPAN. Fujinami, Tsuneo. Karyoku Hatsuden, 18: 517-23(June 1967). (In Japanese).

The development of nuclear power generation in Japan is important for three things: the low-cost and stable energy supply, the advancement of industrial technologies in general, and contribution to the international trade balance. About ten years have passed since Japan tackled its development, and in July 1966 the Tokai power station of JAPC, the first of its kind in Japan, went into operation. The nuclear power generation in Japan is described in the following sections: the present state of nuclear power generation in Japan (the initial stage of nuclear power generation, and the advance to its commercial generation); the trend for the future of nuclear power generation (its economic prospect, and the prospect for the development of nuclear power generation); and problems in the development of nuclear power generation (nuclear fuels, the sites, and domestic production). (NSA of Japan)

14169 ULTRASONIC TESTING OF LIGHT WATER REACTOR FUEL CLADDING TUBES. Tateishi, Yoshinori (Atomic Fuel Corp., Tokyo). Genshiryoku Kogyo, 13: 33-8 (Mar. 1967). (In Japanese).

An investigation was made on the detection of defects in thin-walled, small-diameter, Zircaloy and stainless steel fuel-cladding tubes, by the ultrasonic-probing method using a small probe-element with a point focus. Results are presented. (NSA of Japan)

14170 OPERATION EXPERIENCES OF THE TOKAI POWER STATION, AND THE PLANNING FOR THE TSURUGA POWER STATION. Iwakoshi, Yonesuke; Nomoto, Teruo (Japan Atomic Power Co., Tokyo). Karyoku Hatsuden, 18: 532-40(June 1967). (In Japanese).

The Tokai power station of JAPC employs an advanced Calder Hall-type reactor of electric output 166 MW(e), fueled by natural uranium, moderated by graphite and cooled by CO_2 gas. Because of the earthquakes in Japan, its design was somewhat changed from the original one, and therefore the operating experiences have been unique. A description includes: the situation of the plant operation; vibration of the heat-exchanger tubes; and low-pressure throttle valves for the main turbine. The Tsuruga power station will use a 322 MW(e), boiling-water type reactor from G. E. of the United States, being completed in December 1969. The safety design and the anti-earthquake design of this power plant are described. (NSA of Japan)

14171 AN ANALYSIS OF POWER FLATTENING IN A MULTI-REGION REACTOR. Part II. Amano, Fumio. Denki Shikensho Iho, 31: 1041-50(1967). (In Japanese).

An analytical method of making the thermal flux relatively flat is presented. Discrete absorber effects have been analyzed by applying the Harmonic Method in case of a multiregion reactor. Some problems on the numerical calculation in this method and some applications of the method are investigated. The following conclusions can be derived from the numerical calculation: any example can be calculated by a trial-and-error technique; an optimum division method exists in the case of two control regions from the point of view of the minimum amount of the absorber;

the total amount of the absorber decreases as the number of the division regions increases. (auth)

14172 NEUTRON PHYSICS RESEARCH IN NUCLEAR REACTORS. Meyer, K. (VEB Kombinat Kernenergetik, Berlin). Kernenergie, 10: 237-42(Aug. 1967). (In German).

Methods of group constant computation are presented. Techniques for solution to the transport equation are discussed. Applications of numerical techniques to water-cooled reactors are outlined. 62 references. (M.L.S.)

14173 ENHANCING URANIUM UTILIZATION WITH A MOLTEN-SALT BREEDER REACTOR. Kasten, P. R. (Oak Ridge National Lab., Tenn.); Strauss, S. D. Power, 111: 110-12 (Nov, 1967).

A description of the molten salt breeder reactor (MSBR) is given. Use of this type of reactor for power production is discussed. (M.L.S.)

14174 TRANSIENT BEHAVIOR OF THE HWOCR WITH A POSITIVE POWER COEFFICIENT. Bevilacqua, F.; Coppersmith, W. C.; Musick, C. R. (Combustion Engineering Inc., Windsor, Conn.). Nucl. Appl., 4: 70-8(Feb. 1968).

The positive coolant coefficient of reactivity characteristic of a large, economic heavy water moderated, organic cooled reactor (HWOCR) may make the power coefficient slightly positive. Therefore, the inherent reactor response characteristic of a positive power coefficient was studied dynamically to determine if a practical controller and shutdown system could be designed. Reactivity, coolant flow, and coolant inlet temperature perturbations were studied in controlled and uncontrolled situations. It is concluded that with a small positive power coefficient this reactor can be stably controlled with a simple on-off dead band controller and that a relatively unsophisticated shutdown system will prevent damage under severe transient conditions even in the case of a failure of the automatic controller. (auth)

14175 SPECTRA OF POWER REACTOR NEUTRONS. Stefanescu, Al. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 19: 717-50(1967). (In Rumanian).

In order to optimize the power generation of nuclear power plants, the energy spectrum of each of the reactor types must be known. The coolants used to remove the heat create a heterogeneous temperature distribution which in turn affects the neutron energy distribution. From the time of their generation, at the time of fission, until their complete slowing down, the neutrons are subjected to a series of processes involving the interaction of the nuclei with the medium; each of these processes occurs with its own specific probability. As a result of these events, the ultimate spectrum consists of fast, intermediate and thermal neutrons, with energies in the 0.2 to 20 MeV, 0.1 eV to 0.2 MeV and below 0.1 eV, respectively. The neutron spectra were reviewed and discussed at international conferences devoted to this subject. The chief problem lies in the solution of the Boltzmann integral equation which is difficult to do for real lattices. The calculations were therefore made for simplified, homogeneous media. The problem was examined first for a gaseous monoatomic moderator consisting of free protons ($A = 1$) or a gas with heavy atoms ($A \gg 1$), following it up with a review of slow-neutron scattering phenomena, neutron temperature, spatial and energy distribution of neutrons in reactor lattices and the rethermalization of thermal neutrons in power reactors. For the latter case, the unit cell of the CANDU reactor was taken as an example. (Review article, 50 references). (TTT)

14176 REACTOR SAFETY: PRESENT ACHIEVEMENT AND TRENDS. de Vathaire, F. Energ. Nucl. (Paris), 9: 421-8 (Nov. 1967). (In French).

The concept of reactor safety is discussed. Technological aspects of reactor safety are outlined. Reactor safety studies are considered, briefly, for the following types of French reactors: gas-cooled graphite-moderated, gas-cooled heavy water-moderated, light water-moderated, and fast reactors. 28 references. (M.L.S.)

14177 SPECIAL PIPES AND TUBES FOR NUCLEAR POWER GENERATION. Kondo, Yukaka Karyoku Hatsuden, 18: 301-13(Mar. 1967). (In Japanese).

Commercial atomic power plants to be constructed in Japan in the future are mainly light-water reactors developed in the United States — BWR and PWR. Sumitomo Metal Industries, Ltd. is now trying to establish the foundation for manufacture of special pipes for atomic power plants. Among those special pipes are large-diameter stainless steel pipes: pipes of diameters 200 mm to 1 m for the primary coolant system in PWR's, and for the reactor-coolant recirculation system in BWR's; 75 Ni-15 Cr alloy pipes: U-bend long pipes for a heat exchanger in PWR's steam generators; and Zircaloy fuel-cladding tubes: small-diameter, thin-walled tubes of diameters 10 to 15 mm and wall-thicknesses 0.5 to 1.0 mm for BWR and PWR. A review is made on such special pipes for atomic power plants, including the materials, dimensions, methods of manufacturing, problems in the manufacture and uses, and also the results of research and investigations. (NSA of Japan)

14178 OPERATION RECORDS AND EXPERIENCES FOR JPDR. Eto, Tadahiko (Japan Atomic Energy Research Inst.). Karyoku Hatsuden, 18: 524-31(June 1967). (In Japanese).

JPDR — Japanese Power Demonstration Reactor — went critical with 9 fuel assemblies in August 1963, and after the subsequent physical tests up to the full loading of 72 assemblies, it succeeded in the first-in-Japan power generation by atomic energy, in October of the same year. The seal where a control rod penetrated was damaged, and its repair required six months. Upon re-start of operation all the plant characteristics were examined, and the plant passed its completion inspection in August 1965. During the subsequent two years of operation no major troubles occurred. In this period various tests were performed on the plant, and in 1966 it passed the law-stipulated, regular plant-inspection. The plant characteristics in normal operation and the regular inspection are described, and also the treatment of liquid and gaseous wastes and the radiation control. (NSA of Japan)

14179 EFFECT OF THE TIME-DELAYS AND THE CHANGE OF PLUTONIUM ISOTOPE COMPOSITION ON THE DYNAMICS OF EXPANDING SYSTEMS OF NUCLEAR POWER PLANTS. Frankowski, Waclaw (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 12: 1057-65(1967).

A mathematical model of the dynamics of an expanding system of nuclear power plants takes into account two essential factors: the effect of the time-delays and the change with time of the characteristic parameters of the system resulting from the change of plutonium isotope composition. The influence of these two factors has been analyzed and compared by the method presented in the paper. (auth)

14180 POWER BUILD-UP IN A FAST REACTOR SYSTEM. Frankowski, Waclaw (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 12: 1185-93(1967).

The dynamics of a large fast reactor are considered. Effects of initial isotope composition on power buildup are considered. Three fuel management schemes are discussed: initial isotope composition of the ^{239}Pu core with separate management schemes, arbitrary initial isotope composition of the core with separate management, and arbitrary initial isotope composition of the core with mixed management. (M.L.S.)

14181 AUTOMATION OF THE FUEL ELEMENT HANDLING SYSTEM AT THE MZFR NUCLEAR POWER STATION IN KARLSRUHE. Graf, Guenther; Severin, Christian (Siemens Aktiengesellschaft, Technische Stammabteilung Energieversorgung, Erlangen, Ger.). Siemens-Z., 41: 944-8(Dec. 1967). (In German).

At the MZFR nuclear power station the fuel elements are changed continuously by a specially developed system incorporating a refuelling machine, transfer machine and transfer tube. These devices are controlled by the Siemens functional group control system. A description is given of the solutions found to the special problems that arose. (auth)

14182 CONSTRUCTION AND THERMAL LAYOUT OF THE 300 MW BLOCK UNIT IN THE OBRIGHEIM NUCLEAR POWER STATION. Lepie, Guenther; Martin, Arno. At. Strom, 13: 141-3(Nov.-Dec. 1967). (In German).

A description is given of the general construction of the installation and of the main features of the thermal layout of the 300 MW block unit. Further, an explanation is given of the reactor cooling and pressure maintenance system, and attention is called to several improvements in the reactor installation when compared with the pressure water reactors of the previous generation. (auth)

14183 THE CONSTRUCTION OF THE REACTOR CORE AND OF THE FUEL ELEMENTS IN THE OBRIGHEIM NUCLEAR POWER STATION. Holzer, Rolf; Knoedler, Deithelm. At. Strom, 13: 144-6(Nov.-Dec. 1967). (In German).

The 121 fuel elements which are placed close together are of the same type and symmetrical. They are held in the core framework, which takes the form of a pot hung in the reactor pressure vessel. The control rods are divided into separate absorber fingers which, when inserted, fit into the fuel elements to form a suitable constructional unit. In the thermohydraulic sense the core is open, because an exchange of cooling water is possible even over the boundaries of neighboring fuel elements. (auth)

14184 PHYSICAL LAYOUT OF THE REACTOR CORE IN THE OBRIGHEIM NUCLEAR POWER STATION. Etzel, Wolfgang; Maerkl, Hans. At. Strom, 13: 147-50(Nov.-Dec. 1967). (In German).

The main considerations and criteria in the neutron physics involved in the layout of the reactor core are discussed. The use of a multi-zone core from the points of view of enrichment and burn-up, as well as a suitable fuel element loading and changeover scheme, make a small power form factor and high fuel consumption possible. For reactivity control movable absorber rods and a chemical control system based on boric acid are used. A reactivity balance sheet is given, and the neutron kinetics of the reactor are explained. (auth)

14185 THERMAL DESIGN OF THE REACTOR AND OPERATION OF THE OBRIGHEIM NUCLEAR POWER PLANT. Orth, Karlheinz; Ulrych, Gerhard. At. Strom, 13: 150-5(Nov.-Dec. 1967). (In German).

The thermal design of the Obrigheim Power Reactor is discussed. Statistical power distribution in the core is shown; temperature distributions along the coolant channels are presented. Effects of core inlet temperature, coolant inlet temperature, and pressure are given. (M.L.S.)

14186 THE MAIN COMPONENTS IN THE REACTOR INSTALLATION FOR THE OBRIGHEIM NUCLEAR POWER STATION. Dorner, Heinrich; Schabert, Hans-Peter. At. Strom, 13: 156-62(Nov.-Dec. 1967). (In German).

The primary flow circuit in the nuclear power station is subjected to a thorough stress analysis. The cylindrical part of the reactor pressure vessel comprises three rings which are forged without seams. The two steam generators have vertical bundles of U-tubes and natural circulation on the secondary side. The two single-stage main circulation pumps are fitted with high-pressure water seals which require no maintenance. The 32 control-rod drives work on the principle of the magnetic step-by-step jack. When exchanging fuel elements, the control rods and the elements are transported in a double grab. (auth)

14187 REACTOR AUXILIARY SYSTEMS AND ANCILLARY INSTALLATIONS IN THE OBRIGHEIM NUCLEAR POWER STATION. Kausz, Ivan-Antal; Putschoegl, Gert. At. Strom, 13: 163-8(Nov.-Dec. 1967). (In German).

The chemical and volume control systems for Obrigheim are discussed; layouts are shown. Secondary coolant loops are schematically presented. The reactor ventilating system is shown schematically; air cleaning methods are considered. Emergency core cooling is discussed. (M.L.S.)

14188 TECHNOLOGY OF THE FUEL ELEMENTS IN THE OBRIGHEIM NUCLEAR POWER STATION. Stehle, Heinz; Zeller, Walter. At. Strom, 13: 174-7(Nov.-Dec. 1967). (In German).

The manufacture of the fuel elements is described. Information on the interplay of control-rod drive, use of control, and fuel element. The manufacture of the fuel pellets is continuously controlled during the process, and random samples are taken. Each batch of sheath tubes is checked for physical, chemical and mechanical properties. Details are given of fuel-rod manufacture, in particular of surface treatment and checks on welding. Manufacture and continuous control of the distance pieces are described, and also the installation and testing of the fuel element. (auth)

14189 TURBINE SETS AND STEAM-FEEDWATER CYCLE FOR OBRIGHEIM NUCLEAR POWER PLANT. Bald, Arnold; Duroy, Heinz-Ulrich; Lepie, Guenther. At. Strom, 13: 178-87 (Nov.-Dec. 1967). (In German).

The steam-power conversion system for the Obrigheim Power Reactor is detailed. Equipment is described; ratings and design parameters are given. The steam and feed water cycle is discussed. Construction of the turbines is described. Corrosion-inhibition measures, used in the system, are discussed. (M.L.S.)

14190 INSTRUMENTATION AND PROCESS CONTROL FOR OBRIGHEIM NUCLEAR POWER PLANT. Hellmerichs, Klaus; Pannewick, Alfons; Reimann, Karl. At. Strom, 13: 188-93(Nov.-Dec. 1967). (In German).

A schematic of the overall layout of the automatic process control system is shown. Instrumentation for the primary coolant cycle is discussed; a schematic is given. The reactor protective systems and neutron instrumentation systems are detailed. (M.L.S.)

14191 CONTROL OF OBRIGHEIM NUCLEAR POWER PLANT. Aleite, Werner; Lepie, Guenther; Rauscher, Theodor. At. Strom, 13: 194-8(Nov.-Dec. 1967). (In German).

The control systems for the Obrigheim Power Reactor are discussed; a layout is given. Regulation of turbines, steam equipment and water supply, and coolant pressure is discussed. (M.L.S.)

14192 HIGH CURRENTS- AND AUTOMATIC CONTROL TECHNIQUES FOR OBRIGHEIM NUCLEAR POWER PLANT. Stein, Hermann; Borst, Alexander; Mitsch, Adolf. At. Strom, 13: 199-204(Nov.-Dec. 1967). (In German).

The electrical system for the Obrigheim Power Reactor is detailed; an over all layout is presented. The design of the switching layout is discussed Cables, cable leads, and automatic controls are described. (M.L.S.)

14193 PLANNING AND BUILDING DEVELOPMENT OF THE OBRIGHEIM NUCLEAR POWER STATION. Goepel, Rudolf; Dilcher, Heinrich; Grueger, Hermann; Herborn, Guenter. At. Strom, 13: 205-10(Nov.-Dec. 1967). (In German).

A discussion is given of site conditions for the building design of the nuclear station, and of the planning and arrangement of the buildings, in consonance with the function of the installation. A description is given of the main characteristics of the structural foundations, of the building construction and of the actual erection of the reactor building. (auth)

14194 TECHNICAL DATA FOR THE OBRIGHEIM NUCLEAR POWER STATION. At. Strom, 13: 216-22(Nov.-Dec. 1967). (In German).

A summary of data is given for the entire Obrigheim power station. All parameters are listed for reactor, steam, and all auxiliary systems. (M.L.S.)

14195 DESIGN OF PRESSURISED WATER NUCLEAR POWER STATIONS. Frewer, H.; Lepie, G.; Martin, A. Brennst.-Waerme-Kraft, 19: 513-19(Nov. 1967). (In German).

Optimising the costs of power generation in nuclear power stations is subject to more complicated boundary conditions than for conventional power stations. The nuclear conditions, use of new materials, etc., have a decisive effect on the thermodynamic aspects of the design. On the example of a pressure water reactor it is shown how the different design and fuel cost structures affect the overall design. (auth)

14196 THE NUCLEAR POWER STATION LINGEN. Schmoczer, R. Brennst.-Waerme-Kraft, 19: 519-27(Nov. 1967). (In German).

A description is given of the design and operation of the Lingen nuclear power station, which will be put into operation in November of this year. Starting with the basic circuit the following are described: the individual parts of the installation and their tasks, the circuits, the control and supervision, the equipment for supplying internal power requirements and the safety equipment. (auth)

14197 THE NUCLEAR POWER STATION OBRIGHEIM. Brennst.-Waerme-Kraft, 19: 528-32(Nov. 1967). (In German).

A detailed description of the Obrigheim Power Reactor is given. Design and operating parameters for each of the systems are presented in tabular form. (M.L.S.)

14198 NUCLEAR POWER IN SWEDEN. Skowronek, M. Brennst.-Waerme-Kraft, 19: 534-40(Nov. 1967). (In German).

In the context of the general situation of the power generation industry in Sweden, the necessity of developing nuclear power is pointed out. The institutes and organisations which are primarily participating in the new developments and their respective tasks are described. Results of investigations and experience on existing nuclear power stations are given and planned installations are described. (auth)

14199 NUCLEAR POWER TODAY. Hurley, F. I. (United Kingdom Atomic Energy Authority, Risley, Eng.). Electron. Power, 13: 363-5(Oct, 1967).

Nuclear reactors are characterised by high capital cost and low fuel costs. Economic solutions have been found to the particular problems imposed by radioactivity, and the pattern of future development will be aimed at reducing the cost of electricity by using larger reactors, improved components, and more advanced fuels. In the late 1970s, fast reactors will burn and produce plutonium and therefore operate with very low fuel costs, but thermal reactors may well still be built in the 1980s to provide the plutonium needed for the expanding fast-reactor system. (auth)

14200 DEVELOPMENT OF GAS-COOLED REACTORS. Dent, K. H. (United Kingdom Atomic Energy Authority, Risley, Eng.). Electron. Power, 13: 366-9(Oct. 1967).

A survey is presented of the development of gas-cooled reactors for the generation of nuclear power in Britain—from the research

reactors at Harwell in 1947–48 to the experimental Dragon reactor now in operation at Winfrith. (auth)

14201 ECONOMICS OF NUCLEAR POWER. Iliffe, C. E. (United Kingdom Atomic Energy Authority, Risley, Eng.). Electron. Power, 13: 377-9(Oct. 1967).

Owing to its low fuel-replacement costs, the nuclear station is able to show an economic improvement over the coal-fired station. Although ^{235}U costs about one million times as much per unit weight as coal, the heat energy obtainable from it is some four million times greater. (auth)

14202 TWISTED TAPES FOR INCREASED POWER DENSITY. Rosuel, A.; Rouvillois, X. (SNECMA, Paris). Nucl. Eng., 13: 43-5(Jan. 1968).

Experimental studies are reported on flow and heat transfer characteristics of BWR fuel assemblies which have twisted tapes in the sub-channels between the rods to induce a swirling flow. At an inlet quality of –3% the tapes gave an increase in critical heat flux of nearly 100%. Problems of mechanical behaviour and fabrication are discussed. A preliminary examination of the economics suggests a possible saving of 4 to 5% on generating cost for a 600 MW(e) power station. (UK)

14203 HUNTERSTON B. Nucl. Eng., 12: 924-5(Dec. 1967).

The 1250 MW(e) AGR power station to be built in Scotland will be similar to Hinkley "B". The design is briefly described and the main parameters are listed. (UK)

14204 ECONOMICS OF THE ATOMIC POWER PLANT IN A COUNTRY WITH WATER POWER. Gilli, Paul Viktor. Elektrotech. Maschinenbau, 84: 272-81(June 1967). (In German).

A nuclear power plant with a unit output of ~300 Mw, such as is now feasible for the Austrian power net, is economically superior not only to coal or oil fired steam plants, but also to water power plants. Economic analysis of such a power plant is presented. (TSS) (BBB)

14205 CHANGING APPROACH TO NUCLEAR COSTS. Elec. Rev., 181: 626(Oct. 27, 1967).

Economics of nuclear power development are briefly reviewed. The whole time-stream and spectrum of costs over the life of the nuclear power station that arise from its insertion into a power system and a country's economy are considered. Discount cash flow techniques are used in this analysis. (TSS) (BBB)

14206 NUCLEAR POWER IN BRITAIN. Engineer, 224: 513-15(Oct. 20, 1967).

The present and projected state of nuclear reactor power development in the United Kingdom is outlined. At present 3700 MW of advanced gas-cooled reactor (AGR) is planned in addition to the 5000 MW of the Magnox programme. Specialized equipment provided for the postirradiation examination of fuel by remote control is described. A new technique was developed for rapidly machining the fins on stainless steel AGR fuel cans to a high standard of dimensional accuracy. Development of an all-ceramic fuel in the form of pins is discussed. The 100-MW Steam Generating Heavy Water Reactor (SGHWR) at Winfrith which went critical on September 14, 1967, is described, as are the design and construction of the prototype fast reactor (PFR) at Dounreay. Specifications and performance of various materials used in these reactors are given in detail. (BBB)

14207 NORTHWEST POWER PROGRAM. Black, David S. (Bonneville Power Administration, Oregon). Power Eng., 71: 38-41(Aug. 1967).

New nuclear-powered installations building or planned for the northwestern states are described in a survey of power requirements for that region. The Portland (Oregon) General Electric Co. proposes to build a 1000-MW nuclear plant, on the lower Columbia River, northwest of Portland. The Washington Public Power Supply System, operator of the 800-MW nuclear plant at Hanford, also has proposed to build a new nuclear plant of 1000 MW. (TSS) (BBB)

14208 GREAT BRITAIN: AN ALTERNATIVE ECONOMICAL SOURCE OF ENRICHED URANIUM FUEL. Franklin, N. L. Atom, No. 135, 8-12(Jan. 1968).

The subject is discussed under the following headings: introduction; supply and demand; estimated separative work requirements 1975 to 1980 (U.K., U.S.A., Euratom countries, other European countries); cost targets for an alternative supplier; and the U.K. position (scale of programme, electricity tariff, escalation of construction costs, rate of return on capital, and U.K. terms for supply for enrichment). (UK)

14209 PLUTONIUM FUEL ELEMENT MANUFACTURE FOR THE PROTOTYPE FAST REACTOR. Parkinson, N. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Chem. Brit., 4: 14-15(Jan. 1968).

An outline is given of the design and development of the fuel element plant under construction with emphasis on plant arrangement and handling methods. The requirement is for a plant producing annually several tonnes of fuel containing 20 to 30% Pu. Flexibility is required since replacement elements for PFR may have variants in fuel material or in geometrical configuration. The main fuel development programme has been centered on mixed UO_2/PuO_2 fuel, but the possibility of replacing oxide by carbide has been taken into account. A brief description is given of the design and manufacture of fuel pins and their assemblies. Toxicity, criticality, and radiation problems associated with handling of the Pu are briefly discussed. (UK)

14210 COMPACT SODIUM-COOLED NUCLEAR REACTOR INSTALLATION AT KARLSRUHE (KNK). A PRELIMINARY STEP TOWARDS THE SODIUM-COOLED BREEDER REACTOR. Tebbert, Hubert (Gesellschaft fuer Kernforschung mbH, Karlsruhe); Brudermueller, Gerhard; Harde, Rudolf; Stoehr, Karl Walter. At. Strom, 13: 117-129(Sept.-Oct. 1967). (In German).

A discussion of the compact sodium-cooled reactor at Karlsruhe (KNK) is presented. The 19MW(e) is scheduled to be operable by 1967. Bases for project administration are delineated. Preliminary plant design data are tabulated. The general layout of the installation is described. Specific systems are discussed briefly. Reactor core parameters are given. 11 references. (M.L.S.)

14211 NUCLEAR SUPERHEATING TYPE REACTOR. Yamauchi, Hajime (to Hitachi Ltd.). Japanese Patent 1966-11600. June 27, 1966. Filed May 24, 1963.

In the nuclear-superheating type reactor proposed, the part where coolant water is boiled and the part where saturated steam produced is superheated are situated in the same reactor core. The heat source, employed in the superheating part, is used to preheat feedwater. Considerable improvement in the thermal efficiency, is obtained. Directly above the boiling section, the superheating section is located where saturated steam is superheated by means of liquid metal fuel. This heat source, which is a fluid, is circulated in a closed loop through the superheating part and then through the outside of the reactor core. A steam generator and a heat exhanger are in the loop; in the former, water separated from the steam (above the boiling part) is made into steam (which goes to the turbine) and in the latter, feed-water to the boiling part is preheated. (NSA of Japan)

14212 REACTOR CONTAINMENT VESSEL. Yamauchi, Hajime (to Hitachi Ltd.). Japanese Patent 1966-11958. June 30, 1966. Filed Aug. 14, 1963.

In conventional reactor-containment vessels, when a major accident occurs, the containment of fission gases is accomplished by means of "fission-gas containment valves" in the pipes of steam and feed-water which pass through the containment-vessel wall. Considerable pressure is applied to the valves for a long period of time, causing some leak of fission gases. In the reactor containment vessel proposed such drawbacks are largely eliminated. The reactor containment vessel is made of an outer and an inner vessel, which are nearly buried underground; the space between the walls of the two vessels is filled with water. The pressure vessel, containing a reactor core, is placed in the inner vessel, which is in turn enclosed in the outer vessel. Automatic "inside-outside separation valves" are installed in the pipes of steam and feed-water which connect to the pressure vessel where the pipes penetrate the wall of the outer vessel. (NSA of Japan)

14213 METHOD FOR SCRAMMING A BOILING WATER TYPE REACTOR. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1966-11960. June 30, 1966. Filed July 15, 1963.

An improved method is proposed for scramming a boiling-water type reactor in which light water is used both as the moderator and coolant; the steam produced in the reactor is directly led to the turbine generator. A vessel containing the reactor is enclosed in an air-tight concrete containment structure. To the reactor-containing vessel are connected steam and water pipes which enter through the concrete wall of the containment structure. These two pipes of steam and water are connected by means of a valve inside the concrete structure. When the reactor is in normal operation, this valve is closed. At the time of a reactor accident the valve is opened in order to introduce emergency cooling-water from the outside through the two pipes. (NSA of Japan)

14214 DEVICE FOR FIXING REACTOR FUEL ELEMENTS. Aoki, Naoji (to Hitachi Ltd.). Japanese Patent 1966-319. Jan. 12, 1966. Filed Feb. 20, 1963.

The floating up of fuel elements in the reactor coolant can be prevented under any conditions. At the lower end of a fuel element are installed claws, which open in the radial direction and which

rotate horizontally with a pin as the axis. A fuel-element support plate is located at the bottom of the reactor core; this plate has holes for entrance of the lower ends of fuel elements with only the claws being able to come through the holes. Underneath this plate is installed another plate with semi-circular protrusions (on the upper side) opposed to the respective pairs of claws. When the latter plate is moved upward, the protrusion hits the claws and presses them open, thereby holding firm the fuel element in the core coolant. (NSA of Japan)

14215 METHOD OF CONTROLLING A NUCLEAR REACTOR PLANT AND APPARATUS THEREFOR. Kagi, J. (to Sulzer Brothers Ltd.). Canadian Patent 765,918. Aug. 22, 1967. Priority date Sept. 10, 1962, Switzerland.

Increased load on this nuclear power plant generates a signal which in turn increases the neutron flux by suitable movement of control rods. After the flux increase another signal speeds up the coolant flow rate and the input of feedwater. Thus more energy reaches the turbine to raise the power output. Delay of the feedwater supply relative to the steam outflow makes is possible to utilize the heat capacity of the steam generator when a sudden increase of load occurs. (F.S.A.)

14216 COOLING SYSTEM FOR NUCLEAR REACTORS. Bohdansky, J.; Busse, C.; Grover, G. M. (to EURATOM). Canadian Patent 765,919. Aug. 22, 1967. Priority date Dec. 14, 1964, Germany.

In this reactor, especially designed for direct conversion of heat to electricity, a "heat pipe" is used instead of continuous fluid flow for heat transfer. The tubular fuel element surrounds a heat pipe which contains a quantity of liquid metal and is lined with a wick. Similar pipes are inserted into the moderator and reflector. The reactor core is horizontal and these pipes terminate in heat sinks to the right and left ends of the core. Heat transfer occurs by a cycle of vaporization and condensation of liquid returning by capillary action along the wick lining. The heat is converted to electricity by thermionic emitters and collector electrodes located in the heat sinks. Ag, Li and Cs are used as heat carrier fluids for the vaporization-condensation cycle depending on the temperature range required. Operating temperatures are 1800°C at the emitter electrode, 1000°C at the collector electrode and 500°C in the moderator and reflector. (F.S.A.)

14217 FUEL ELEMENT FOR NUCLEAR REACTOR. Boudouresques, B.; Maillet, E.; Pelce, J. (to Commissariat a l'Energie Atomique). Canadian Patent 764,048. July 25, 1967. Priority date July 6, 1962, France.

This tubular fuel element is intended for use in a gas-cooled, solid-moderated reactor. The uranium fuel tube, possibly slightly enriched, is clad on both inside and outside surfaces. The internal cladding has small corrugations, and the external surface has cooling fins. The result is a high rate of fluid flow and good heat transfer within a relatively small diameter thus avoiding the penalty of neutron absorption from a large surface area. The coefficient of friction for the inner can is 5 to 25 times less than that for the outer can. (F.S.A.)

14218 NUCLEAR REACTOR REFUELLING DEVICE. (to Commissariat a l'Energie Atomique). French Patent 1,326,401–(Add. 3). Feb. 2, 1966. Filed Nov. 18, 1964. 3rd addition 86,733.

The system of insertion and withdrawal of fuel element magazines for a refuelling device of a gas-cooled reactor is disposed within a tunnel provided with a lock-chamber, which is located within the thickness of the reactor containment shielding. The orifice which provides access from a storage area to the lock-chamber is closed by means of a door which is movable within the storage area. The displacement of a door-flap for the purpose of freeing the orifice of the corresponding lock-chamber is carried out by means of rotation of the flap about a stationary vertical pivot. The movement is controlled from the exterior of the reactor vessel and can be effected by means of a jack, the action of which subsequently ensures leak-tight closure. (IIB)

14219 NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,414,851. Sept. 13, 1965. Filed Aug. 27, 1964.

A method of operation of a fast-neutron reactor consists in dividing the reactor core into at least two regions having symmetry of revolution with respect to a common axis parallel to the direction of flow of a coolant within the reactor core. The regions are occupied by fuel containing the same amount of fissionable material, and the proportion of fuel per unit volume of the core is different from one region to another and higher in the outermost region. The cooling of the core consists of circulating the coolant at a different velocity from one region to the other and at a higher velocity in the outermost region. (IIB)

14220 NUCLEAR POWER ECONOMICS: ANALYSIS AND COMMENTS, 1964. PREPARED FOR THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-EIGHTH CONGRESS, SECOND SESSION, OCTOBER 1964. Washington, D. C., Joint Committee on Atomic Energy, 1964. 55p. GPO $0.20.

14221 UNITED KINGDOM NUCLEAR REACTOR PROGRAMME. REPORT FROM THE SELECTED COMMITTEE ON SCIENCE AND TECHNOLOGY, SESSION 1966-67. Palmer, Arthur. London, Her Majesty's Stationery Office, 1967. 592p. £ 2, 19s.

The organisation and present status of nuclear power in the UK are reviewed in detail, and the proceedings of the committee are recorded. Recommendations are made for organisational changes, and with regard to the future reactor programme. (UK)

14222 ENERGY IN EUROPE, 1945–1980. Jensen, W. G. London, Foulis and Co., 1967. 211p. 45s.

Section headings of this book are as follows: The post-war fuel shortage, 1945–57, and the two-fuel economy; the years of surplus from 1957 to present day; supply and demand of energy in Europe from present day to 1980. Matters discussed include the development of nuclear power. (UK)

14223 THE POLITICAL ECONOMY OF NUCLEAR ENERGY: AN ECONOMIC STUDY OF CONTRASTING ORGANISATIONS IN THE UK AND USA, WITH EVALUATION OF THEIR EFFECTIVENESS. Burn, Ducan. Research Monographs No. 9. London, Institute of Economic Affairs, 1967. 152p. £ 1, 1s.

The history of the development, the claims made for competitiveness, and the probable future of the nuclear power industries of the US and UK are reviewed and discussed. It is argued that the development of cheap nuclear power has been slower under the UKAEA monopoly and centralisation than under the competitive regime of the US, and that the resulting nuclear system adopted in Britain has been much more costly than the American. Costs of BWR, PWR, and AGR stations are compared. Criticism is made of the assessment by the CEGB of the tenders for the Dungeness 'B' station, and of their over-elaborate tendering procedures and specifications. (UK)

14224 FAST-REACTOR CONTROL ELEMENTS. Terasawa, Shoichi (to Hitachi Ltd.). Japanese Patent 1967-318. Jan. 11, 1967. Filed Dec. 22, 1964.

The improved control elements of the mixed neutron absorber- and moderator-type for a fast reactor are proposed. The advantages obtained are the reduced size, the light weight and a sufficiently large control effect. The control element is composed of a neutron absorber in the intermediate energy region, and a neutron moderator for fast to intermediate energies. The fast neutrons are mainly moderated to the intermediate region where they are absorbed by the absorber. The control element is composed of a neutron absorber in the intermediate region, a small amount of a thermal neutron absorber, and a neutron moderator for fast to intermediate energies. Thermal neutrons can also partially be absorbed. The fuel element is composed of a neutron absorber in the intermediate region, and a neutron moderator for fast to intermediate energies, capable also of thermal-neutron absorption. Neutrons are absorbed by both the "intermediate energy" absorber and the moderator. (NSA of Japan)

14225 NUCLEAR REACTOR. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1966-14559. Aug. 16, 1966. Filed May 10, 1963.

A totally new type of reactor is proposed which incorporates secondary coolant superheating within the pressurized water reactor. Some of the advantages to the proposed reactor are elimination of the vapor- and liquid-separator, of thermal shields, and the resulting compactness of the whole system. It consists of the reactor pressure-vessel; the reactor core held within a cylindrical body installed concentric to the pressure vessel; the "secondary coolant" boiling and superheating region devoid of the vapor-and-liquid separator located between the cylindrical body and the pressure vessel (wall) which leads to outside the pressure vessel; the so-called "closed loop" for the primary coolant which runs through the core; primary coolant, also as moderator, forcedly circulated through the closed loop; and secondary coolant, which receives "heat" from the primary coolant in the boiling and superheating region and goes out of the reactor as superheated steam. Primary and secondary coolant act as the reflector to the reactor core. (NSA of Japan)

14226 FUEL ROD FOR A SUPERHEATING-TYPE REACTOR. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1966-16357. Sept. 14, 1966. Filed Aug. 14, 1963.

An improved fuel rod is proposed for mixed-spectra superheating reactors. The advantages, obtainable from the fuel rods, are high economy in fuel and construction; high operating efficiency and safe reactor operation. The fuel rod consists of the outer tubular body; an inner concentric tube, composed of enriched uranium and Zr (or other less neutron-absorbing material) cladding for both outside and inside which is located in the lower half of the outer tubular body; another, inner concentric tube, located in the upper half, composed of enriched uranium (or plutonium) and stainless steel (or other high heat-resistant material) cladding which is connected firmly to the other tube; and the partition, separating the space between the outer tubular body and the connected inner tubes at the position of the connection. The upper end of one tube and the lower end of the other tube have no fuel. Coolant water enters orifices in the outer tubular body just below the partition, flows downwards, enters orifices in the lower tube, flows up through the tube while heated, then through the connection while boiled, and finally (after the connection) through the upper tube while superheated with part of the saturated steam flowing through the space between the outer tubular body and the tube after coming out of the orifices just above the connection. (NSA of Japan)

14227 THE EFFECT OF FUEL DIAMETER ON THE DOPPLER TEMPERATURE COEFFICIENT OF REACTIVITY IN FAST REACTOR SYSTEMS. Miller, Laurence Bernard. Urbana, Ill., University of Illinois, 1967. 119p.

Thesis.

A theoretical method for analysis of the Doppler effect is developed; this is then used to determine fuel element size effects on the Doppler coefficient in a typical fast breeder reactor. Variations in Monte Carlo methods are used to eliminate approximations and assumptions; these are described and formulated mathematically. The AMC digital computer program is described; results obtained by using this are compared to results from other computer codes. (TSS)

14228 LIQUID MODERATED NUCLEAR REACTOR. Deighton, Thomas (to Babcock and Wilcox, Ltd.). U. S. Patent 3,356,583. Dec. 10, 1964.

The description of a pressurized water-moderated heterogeneous reactor is presented. The core consists of a plurality of fissile material-bearing fuel elements arranged in a fixed lattice with a plurality of fixed flow channels. The moderating water circulates through the core at pressures of 2800 to 3200 lb/in.^{2}. An external heat exchanger with a secondary fluid is used for heat extraction. (TSS) (U.S. Pat. Gazette)

Marine and Portable Power Reactors

Refer also to abstract 14142.

14229 (HIT-242) FABRICATION OF THE PM REACTOR CORES (TYPE 2 DESIGN). (Hittman Associates, Inc., Baltimore, Md.). Jan. 1967. Contract AT(30-1)-3131. 46p. Dep. CFSTI.

The fabrication of the Type 2 replacement cores for the PM reactors is described. The PM-3A replacement is designated Core IV and the PM-1 replacement Core V. The cores were procured on a fixed price basis using a product type specification, NYO-10537. Included are a general core description, materials and product requirements, fabrication processes and tests, and quality control results. Problems encountered in materials procurement, fabrication and testing are presented. (auth)

14230 (NUS-265A) THE ECONOMICS OF NUCLEAR FUEL IN MARITIME APPLICATIONS. Summary Report. McLeod, N. B. (NUS Corp., Washington, D. C.). Apr. 1966. 70p.

The basic cost factors of nuclear fuel for use in present technology pressurized water maritime reactors are investigated. Several currently proposed maritime reactor core designs are evaluated, process cost parameters are identified, future trends in basic materials costs, process costs, and fuel performance are defined, and the resultant costs and cost trends are compared with central station power reactors employing similar fuel cycle technology. (H.D.R.)

14231 (NYO-10743) SPECIFICATION FOR PM TYPE NUCLEAR REACTOR CORES (TYPE 2 DESIGN). (Hittman Associates, Inc., Baltimore, Md.). Jan. 1967. Contract AT-(30-1)-3131. 91p. Dep. CFSTI.

Specifications for Type 2 replacement cores for the PM reactors are presented. Included are core descriptions, materials and product requirements, fabrication processes and tests, and quality control results. (D.C.C.)

14232 (TID-24219) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. ML-1 CYCLE OPTIMIZATION. Ryan, R. D.; Dieter, G. P. (Aerojet-General Nucleonics, San Ramon, Calif.). Aug. 1965. Contract AT(10-1)-880. 20p. (AN-AGCR-931). Dep. CFSTI.

A study was conducted to investigate the effects of turbine–compressor set design variables on overall system performance and to define turbine-compressor match point requirements for the reference ML-1 system in support of the current Clark and Stratos turbine–compressor set development programs for the ML-1 power plant. A computer program was developed for calculating ML-1 system performance over a wide range of operating conditions. A total of 480 computer runs were made with varying mass flow rates, compressor pressure ratios, and turbine–compressor efficiencies over the ranges consistent with the basic ML-1 system design criteria; ambient and turbine inlet temperatures of 100°F and 1200°F, respectively, were common to all runs. Implicit in the results is the assumption that the system and turbine–compressor sets are properly matched. It was determined that the turbine expansion ratio is defined by the compressor pressure ratio and flow rate and is virtually unaffected by turbine–compressor efficiencies over the range studied. The effect of mass flow rate on overall system performance was investigated. It was determined that an optimum flow rate exists for each combination of turbine and compressor efficiencies due to precooler performance degradation and increased loop pressure losses although the turbine–compressor set net power increases with flow rate. It was also determined that the compressor pressure ratio (and hence turbine expansion ratio) can be varied over a broad range without significantly affecting the overall plant performance. (auth)

14233 (JPRS-43834) TESTING THE CONTROL ROD DRIVES OF MARINE NUCLEAR REACTORS. Maslenok, B. A. Translation of pp 1-164 from Ispytaniya Privodov Upravleniya Sudovykh Yadernykh Reaktorov, Shipbuilding Publishing House, Leningrad, 1967. 173p. CFSTI.

The basic requirements imposed on the design of marine reactor control rod drives are presented, and problems of testing various control rod types are considered. Reliability parameters for the construction of drives are analyzed. Schematics and special features of the test units are presented, and procedures followed when conducting the reliability tests are discussed. (H.D.R.)

14234 BUILDING A NUCLEAR SUBMARINE: SOME PROBLEMS AND THEIR SOLUTIONS. Groom, E. J. Engineer, 224: 343 (Sept. 15, 1967).

Some design and construction features of the nuclear power plant and electrical equipment of the 7500-ton (displacement) submarine H.M.S. Resolution are discussed. The requirement of utmost reliability in the propulsion plants is emphasized. The nuclear reactor is equipped with detailed constant monitoring devices, remotely operated and of assured reliability. Impending trouble can be dealt with by automatic shut-down devices operating rapidly. (TSS) (BBB)

14235 SUDOVYE YADERNYE REAKTORY (TEORIYA I RASCHET). (Marine Nuclear Reactors (Theory and Computation)). Soigin, M. F.; Gusev, A. B.; Labinskii, Yu. V.; Solntsev, N. V. Leningrad, Izdatel'stvo Sudostroenie, 1967. 608p.

The basic theories for calculation of parameters for marine nuclear power plants and associated biological shielding are reported. The reactor theory is explained; thermal and intermediate neutron effects on neutronic, hydraulic, and thermal parameters are considered. Calculations used in the design of the biological shields are examined. (tr-auth)

Rocket and Space Reactors

Refer also to abstracts 12442, 12679, and 14142.

14236 (ANL-7380, pp 37-9) SNAP SYSTEM INSTRUMENTATION. Strahl, Harry (Atomics International, Canoga Park, Calif.).

The experience gained during operation of SNAP reactors with liquid-metal process instrumentation is presented. This experience is based on the operation of several SNAP reactor systems at temperatures up to 1300°F for periods of up to 10,000 hr. Several types of temperature and pressure devices were installed in a loop, and their performances were compared and evaluated prior to selection of instrumentation for the S8DR tests. (auth)

14237 (ANL-7380, pp 47-51) STABLE HIGH-TEMPERATURE DETECTION. Steele III, O. P. (Atomics International, Canoga Park, Calif.).

The accurate determination of the temperatures in a liquid metal fast breeder reactor is necessary for both control and indication.

This is also true in space reactors. During the development of the SNAP reactors, marked improvements have been made in the field of platinum RTD's. The platinum RTD affords a more stable reference temperature-measuring system than a thermocouple in the 1200–1300°F range. Comparative drift rates are shown for the platinum RTD and for a variety of thermocouples for 10,000 hr at these temperatures. The accurate determination of this drift rate by the use of zinc and aluminum melting point physical standards is described. A unique electronic circuit which allows the use of a single RTD to switch more than one bridge circuit at the bridge null point is described. This arrangement eliminates the differential drift rate between set points that occur when separate RTD's are used for each point. (auth)

14238 (ANL–7380, pp 52-62) HIGH-TEMPERATURE THERMOMETRY. Remley, G. A. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.).

Development of high temperature thermocouples for NERVA is discussed. Data are shown on temperature response as a function of time over successive cycles. Results of leak rate testing of thermocouples are tabulated. (M.L.S.)

Process Heat and Desalination Reactors

Refer also to abstract 14142.

14239 TECHNOLOGICAL ADVANCES IN INDUSTRIAL WATER TREATMENT AND DESALINATION. Streatfield, E. L. Effluent Water Treat. J., 7: 537-43 (Oct. 1967).

Conventional as well as nuclear processes in desalination of seawater are reviewed, as well as progress in treatment of raw water for industrial purposes. Consideration is given to the operation of water plants coupled to power generation stations. The U.K. Atomic Energy Authority has designed such a plant to desalinate 30 Mgd of sea water, more than 20 times the size of the largest plant now operating. The nuclear plant comprises an advanced gas-cooled reactor coupled to a conventional multistage flash evaporation plant in 3 integrated units yielding 10 Mgd each. (BBB)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 12472, 12477, 13894, and 14142.

14240 (AAEC/M–76) HIFAR HELIUM CIRCUIT GAS ANALYSER OPERATING MANUAL. Woodward, H. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). June 1967. 17p. Dep.

A description, with operating and emergency procedures, is given of a gas analyzer installed in the helium circuit within the sealed building of the Dido-type reactor HIFAR. (auth)

14241 (AAEC/TM–404) THE FABRICATION OF ^{233}U/ALUMINIUM FUEL PLATES FOR A SUBCRITICAL ASSEMBLY. A Second Report. Bardsley, J.; Ridal, A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug. 1967. 20p. Dep.

Uranium-233 (as 938.66 g UO_2) was fabricated into 176 full-size, 20 half-size and 2 quarter-size Al clad fuel plates. Each full-size plate contained 5 compacts and half-size and quarter-size plates contained 2 compacts and 1 compact respectively; a compact consisted of a cold-pressed dispersion of about 1.5 g of UO_2 in Al. The technique involved mixing UO_2 and Al powders, pressing the compacts in a steel die, end-loading them into a prefabricated Al can and end-welding the can; following this the can underwent radiographic inspection for uniformity, decontamination, leak detection and acceptance tests, and final decontamination. Maximum permissible radiation doses to hands and bodies of the operators were not exceeded. (auth)

14242 (AAEC/TM–408) COMPARISON OF SOME MEASURED AND CALCULATED REACTION RATES IN HIFAR. Bicevskis, A.; Culley, D.; Hesse, E.; Wall, T. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Sept. 1967. 29p. Dep.

The neutron spectrum and flux distribution in the reactor HIFAR was studied by using several fuel cell models and comparing calculated and measured reaction rates and neutron spectra. Satisfactory agreement was obtained between theory and experiment when the complex geometry of the fuel element and the effects of neighbouring elements were taken into account. (auth)

14243 (AE–308) IRRADIATION OF SUPERHEATER TEST FUEL ELEMENTS IN THE STEAM LOOP OF THE R2 REACTOR. Ravndal, F. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Dec. 1967. 95p. Dep.

The design, fabrication, irradiation results, and post-irradiation examination for three superheater test fuel elements are described. These clusters, each consisting of six fuel rods, were successfully exposed in the superheater loop No. 5 in the R2 reactor for a maximum of 24 days at a maximum outer cladding surface temperature of approx. 650°C. During irradiation the linear heat rating of the rods was in the range 400–535 W/cm. The diameter of the UO_2 pellets was 11.5 and 13.0 mm; the wall thickness of the 20/25 Nb and 20/35 cladding was 0.4 mm. The diametrical gap between fuel and cladding was one of the main parameters and was chosen to be 0.05, 0.07, and 0.10 mm. (auth)

14244 (ANL–7380, pp 9-14) ANL PARTICIPATION IN THE FFTF INSTRUMENT DEVELOPMENT EFFORT. Knox, A. E.; Popper, G. F. (Argonne National Lab., Ill.).

A summary of ANL efforts toward development of FFTF instrumentation is presented. Topics discussed include: failed fuel detectors, signal lead connectors, fission gas pressure transducers, in-core flowmeters, and fuel pin thermocouples. (M.L.S.)

14245 (ANL–7380, pp 22-8) EBR-II INSTRUMENTATION EXPERIENCES. Moriarty, K. J. (Argonne National Lab., Idaho Falls, Idaho).

Those experiences with the EBR-II instrumentation with pressure, both static and differential, with temperature-measuring devices, and with level indications are covered in detail. The problems encountered are outlined, and the corrective action taken to rectify a problem is given where possible. The importance of pre-installation data is stressed. Calibration and repair procedures used for filled systems are included for general information and to point out the type of information that must be included in the preinstallation calibration check on a component. (auth)

14246 (ANL–7380, pp 126-7) COMPUTER SYSTEMS FOR FAST TEST REACTORS. Wolfson, Richard (Curtiss-Wright Corp., East Paterson, N. J.).

The digital control system for FFTF places the fast test reactor in a highly flexible control environment and provides a convenient mechanism for evaluation of the facility. Once the sensors and reactor have been proof-tested in this manner, the entire system may become the prototype control system for test reactors of the future. The highest cost element of the FFTF program will be the computer software. However, once developed, this software may itself be a prototype of a compiler system that can find wide usage in fast test reactors. (auth)

14247 (ANL–7380, pp 168-9) SOME LIMITED RESULTS FROM THE EBR-II TEST OF A COUNTING-CAMPBELLING CHANNEL. Popper, G. F. (Argonne National Lab., Ill.).

Some performance data on a wide range neutron monitoring channel for the EBR-2 are given. System response to neutron flux is shown; period response is shown graphically. (M.L.S.)

14248 (ANL–7380, pp 170-3) OPERATING EXPERIENCE WITH SYSTEMS DESIGNED FOR MANEUVERABILITY AND HIGH AVAILABILITY. Epler, E. P. (Oak Ridge National Lab., Tenn.).

The requirement of maneuverability and availability in HFIR has led to the development of a control and protective system. This system is described. (B.G.D.)

14249 (ANL–7380, pp 174-9) SOME DESIGN ASPECTS OF THE PROPOSED EBR-II INSTRUMENTED SUBASSEMBLY SYSTEM. Knox, A. E.; Popper, G. F. (Argonne National Lab., Ill.).

The preliminary concepts of an in-core instrumented subassembly system for use in EBR-II are presented. The system will permit the irradiation of instrumented fuel elements in the reactor with the signal leads from the sensors brought out of the reactor and primary tank to appropriate receiving instruments. The system will replace a control rod and utilizes the normal fuel-handling procedures for removal of the irradiation subassembly upon completion of the experiment. (B.G.D.)

14250 (BNWL–470) FAST FLUX TEST FACILITY REFERENCE CONCEPT. Progress Report. Boyd, C. L.; Shadel, F. H.; Westsik, J. H. (eds.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1967. Contract AT(45-1)-1830. 214p. Dep. CFSTI.

FAST FLUX TEST FACILITY—design of, complete; ventilation flow diagrams for; electrical system for, one line diagrams for; waste disposal, system flow diagram for, liquid

FAST TEST REACTOR—test facilities for, design of in-core and reflector; core for, design parameters for; critical mass

for, total plutonium-239; reflector for, design drawings for; fuel elements for, design of; heat transfer systems for, operating conditions of; sodium coolant systems for; instrumentation and control systems for, design parameters and drawings for; control of, schematic for digital computer for; containment vessel for, description of penetrations of; piping designs for, service
REACTOR FUEL ELEMENTS—design parameters and drawings for FTR; handling of irradiated and nonirradiated FTR
SHIELDING—materials for FTR
HEAT EXCHANGERS (LIQUID-LIQUID)—design and performance data for FTR
PUMPS (LIQUID METAL)—design and performance data for FTR
SODIUM—purification systems for FTR coolant
HELIUM—purification systems for FTR
COMPUTERS—design for FTR digital
REACTOR EXPERIMENTAL FACILITIES—rabbit facility for FTR, design of
REACTOR CONTAINMENT STRUCTURES—penetrations of FTR, description of (M.L.S.)

14251 (BNWL-534) REACTOR PHYSICS DEPARTMENT TECHNICAL ACTIVITIES. Quarterly Report, April–June 1967. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. 84p. Dep. CFSTI.
NEUTRON CROSS SECTIONS—analysis of, use of optical model for theoretical
COMPUTER PROGRAMS—description of fast reactor FCC-IV
REACTOR FUEL ELEMENTS—reactivity worth of PRTR, measurement of; power distributions in Phoenix, measurement in PRCF of; neutron multiplication factors for Phoenix, comparison of experimental and calculated values for; Doppler coefficients for FTR, effects on fuel temperature of variations of
PLUTONIUM RECYCLE TEST REACTOR—neutron fluxes in, ratios of axial peak-to-average; fuel element recycle test facility for, measurement of fuel element reactivity worths in
BORON—reactivity worth of, PRTR batch core measurement of
REACTORS—lattice parameters for uranium dioxide 19-cluster, analysis using RBV Monte Carlo code for; fuel lattices for, temperature coefficient calculations for uranium-233 oxide (UO_2)–thorium-232 oxide
PLUTONIUM RECYCLE CRITICAL FACILITY—reactivity worth measurements of Phoenix core in
HIGH-TEMPERATURE LATTICE TEST REACTOR—Doppler coefficient measurements for, procedures for
FAST TEST REACTOR—physics characteristics of, analysis of split-cone; control rods for, reactivity worth of safety; accident conditions in, fuel pin center-line temperatures under; control rods for, calculations of re-activity worths of; components for, heat generation rates and neutron damage rates in
REACTOR SAFETY—FTR fuel pin centerline temperature under accident conditions
CRITICAL ASSEMBLIES—Doppler coefficients for ZPR-3, comparison of measured and calculated values for; neutron fission rates in ZPR-3, uranium-238 and plutonium-239; neutron spectral measurements in ZPR-3 and ZPR-6,
URANIUM ISOTOPES U-238—neutron fission rates in ZPR-3
PLUTONIUM ISOTOPES Pu-239—neutron fission rates in ZPR-3
REACTOR CONTROL ELEMENTS—reactivity worth calculations for FTR
URANYL NITRATE—critical uranium-235 enrichment for solutions of, determination of uranium
REACTIVITY—worth of uranyl nitrate as function of Uranium-235 enrichment determination of maximum excess
PHYSICAL CONSTANTS TEST REACTOR—reactivity worth measurements in, determination of critical uranium-235 enrichment for uranyl nitrate, using
NEUTRONS—monochromatization of, use of multiple Bragg reflection for high-resolution
CHARGED PARTICLES—relativistic motion of, description of computer program for calculating and plotting eight-dimensional phase-space electromagnetic plane wave-driven (M.L.S.)

14252 (BNWL-566) PRELIMINARY RADIOLOGICAL CONSIDERATIONS INVOLVED WITH THE EXAMINATION OF IRRADIATED FFTF FUEL ELEMENTS. Stevens, A. J.; Swanberg, F.; Watson, E. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1967 Contract AT(45-1)-1830. 16p. Dep. CFSTI.

The determination of appropriate criteria for contamination control in the Fast Flux Test Facility (FFTF) which will allow the processing and examination of the FFTF fuel for any period up to 50 days after discharge is described. Selected isotopes of the fission product inventories are used to establish a gross $\beta-\gamma$ activity estimate as a function of fuel exposure, and time since irradiation. Initially, it was assumed that the ratio of $\beta-\gamma$ activity to α activity might be a useful index for controlling α contamination based on $\beta-\gamma$ sensitive air monitoring of the FFTF fuel examination facilities. Results show that alpha sensitive air monitoring equipment will be necessary. (auth)

14253 (BNWL-614) EVALUATION OF FFTF REACTOR ASSEMBLY DEVELOPMENT AND TESTING PROGRAM. Finch, L. M.; Peterson, R. E.; Toyoda, K. G. (comps.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1967. Contract AT(45-1)-1830. 293p. Dep. CFSTI.

An evaluation of the Fast Flux Test Facility design is given. The overall experimental program needed for resolution of facility design problems is analyzed. The mechanical design of the dispersed split core configuration introduces many problems; these are considered. An engineering design and testing program is presented for the following design features: thermal-hydraulic development; fuel subassembly water, sodium and mechanical testing; core and vessel hydraulics; core vibration; thermal-mechanics; mechanical fit testing; control mechanism development; closed loop prototypes; and instrument development. Development facilities are outlined; a recommended plan of scheduling is given. 30 references. (M.L.S.)

14254 (BNWL-657) PARAMETRIC SCRAM TRANSIENT ANALYSES FOR THE FFTF FAST TEST REACTOR. Hagan, J. W.; Worth, G. A.; Padilla, A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1967. Contract AT(45-1)-1830. 27p. Dep. CFSTI.

Parametric analyses of the transient characteristics of the FFTF fast test reactor for various assumed ramp reactivity inputs which are terminated by trip of the reactor safety system have been performed and the results of these studies are described. In each case the reactor was assumed at operating conditions at initiation of the ramp. System variables included in the study were: the magnitude of the ramp reactivity insertion, the system response time, the safety rod acceleration rate, and the magnitude of the Doppler coefficient. Values of the maximum overheating factors have been analyzed to estimate the values for various fuel damage thresholds. These thresholds include incipient fuel melting of the hottest pin, centerline fuel completely molten, and 50% of the pin cross-sectional area at or above the fuel melting point. (M.L.S.)

14255 (BNWL-CC-886) FAST REACTOR EXPERIMENTS IN THE PCTR AND HTLTR. Heineman, R. E.; Humes, R. M.; Lanning, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1966. Contract AT(45-1)-1830. 19p. Dep. CFSTI.

A description of the theoretical basis for the fast reactor experiments in the Physical Constants Test Reactor (PCTR) and High Temperature Lattice Test Reactor (HTLTR) is given. Calculations are made to determine optimum experimental conditions. Sample spectral calculations, using SEFOR data, are given. Activation and fission ratios for $^{238}U/^{235}U$ and $^{239}Pu/^{235}U$ are shown. 7 references. (M.L.S.)

14256 (CEA-R-3202) INTERPRETATION D'EXCURSIONS DE PUISSANCE DANS UNE PILE A EAU DANS LE CAS OU LE SYSTEME DE REFROIDISSEMENT EST A L'ARRET. (Interpretation of Power Bursts in a Swimming-Pool Reactor When the Cooling System is Stopped). Le Berre, Francois (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Oct. 1967. 40p. (In French). Dep.

A reactivity feedback model concerning swimming-pool reactors with no coolant flow through the core is presented. This calculation method can be used to analyze, up to a certain extent, the experimental data obtained from power bursts resulting from a reactivity step. (auth)

14257 (CEA-R-3339) REACTEUR "PHENIX" LA DETECTION DE RUPTURES DE GAINE. (The Reactor PHENIX: Cartridge Rupture Detection). Graftieaux, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 13p. (In French). Dep.

The role of cartridge rupture detection in the reactor PHENIX is defined. It gives the possible methods, their probable performances, their advantages and disadvantages. The final form of the installation will be determined mainly by the degree of safety required, by the technical possibilities of the reactor design and by the operational flexibility wanted. (auth)

14258 (GA-8304) LATTICE PHYSICS STUDIES. Quarterly Progress Report No. 6 for the Period Ending September 30, 1967. Trimble, G. D.; Gozani, T.; d'Oultremont, P.; Preskitt, C. A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 10, 1967. Contract AT(04-3)-167. 52p. (EURAEC-1948). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Measurements of angular thermal neutron spectra are discussed; results are given. Neutron die-away and mean emission times were measured in several energy domains. Measurement techniques and equipment are described. 16 references. (M.L.S.)

14259 (LA-3768) DESCRIPTION OF EXPERIMENTS LASL-36, -37, -38, -39, -40, -41, AND -42 AND EVALUATION OF THE HAZARDS INVOLVED WITH THEIR IRRADIATION IN EBR-II. Barner, John O. (Los Alamos Scientific Lab., N. Mex.). Aug. 18, 1967. Contract W-7405-eng-36. 27p. Dep. CFSTI.

A description of fuel and cladding irradiation experiments for the LASL fast breeder experimental program is given; the experiment capsules were irradiated in the EBR-II. Operating conditions are tabulated for the capsules; radiation damage to clad materials is given; detailed data for fuel material are presented. Heating rate calculations are given; loop stresses are presented as a function of fission gas pressure. Decay heat is tabulated as a function of time for each capsule; fission product buildup is given. 16 references. (M.L.S.)

14260 (NAA-SR-Memo-12290(Rev.)) ELIMINATION OF THE EFFECT OF A CONSTANT NEUTRON SOURCE IN REACTIVITY MEASUREMENTS. Tuttle, R. J. (Atomics International, Canoga Park, Calif.). May 31, 1967. 36p. Dep. CFSTI.

Elimination of the perturbing effect of a constant neutron source in low-power reactivity measurements can be accomplished by inclusion of this effect in the dynamic reactivity measurement method. This method uses a computer to determine the instantaneous reactivity from the reactor power history. Use of this method is demonstrated, including determination of the source perturbation, for calibration of a regulating rod in the ECEL reactor. The source perturbation ranged from zero to about 6 cents in these calibrations; this was reduced to less than the statistical uncertainty of the measurements, about 0.1 cent, by use of this method. Additional information regarding dynamic reactivity measurements, including a description and listing of the computer program used, is presented. (auth)

14261 (ORNL-TM-689) OPERATING SAFETY LIMITS FOR THE OAK RIDGE NATIONAL LABORATORY RESEARCH REACTOR (ORR). Webster, C. C. (Oak Ridge National Lab., Tenn.). Jan. 11, 1968. Contract W-7405-eng-26. 11p. Dep. CFSTI.

The operating safety limits designate the limits within which the reactor can be operated safely. The limits specified were determined by design or experience. The limits are listed according to the functional components. One section indicates what limitations are placed on experiments, and another section specifies the limitation placed on administration of the operation. (auth)

14262 (WAPD-TM-614) SMALL ^{233}U FUELED SEED-AND-BLANKET CRITICAL EXPERIMENTS. Milani, S.; Weiss, S. H. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Nov. 1967. Contract AT(11-1)-Gen-14. 167p. Dep. CFSTI.

A series of eight small seed-and-blanket critical assemblies were studied at the Bettis Atomic Power Laboratory. Rod-type seed fuel elements which contained either ^{233}U or ^{235}U were utilized so that a direct comparison could be made between the lattice characteristics of the two fuels. Also, blanket regions which contained rod type elements with either natural ThO_2 or 1 w/o $^{233}U\ O_2-ThO_2$ were compared. The eight assemblies were of two principal types. The first type was a rectangular array having a central seed region surrounded by a wet blanket with a metal-to-water ratio of about one, and the second was a hexagonal array having a central seed region surrounded by a tightly packed dry blanket with a metal-to-water ratio of about 9.2. All experiments on these eight assemblies were conducted at 20°C temperature. In addition, two of the wet blanket assemblies were studied in the High Temperature Test Facility at 480°F and 650 psi. (auth)

14263 (AEC-tr-6910) STUDY OF THE SAFETY OF THE ERMINE EXPERIMENT. Bouchard, J.; Carre, J. C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by D. R. deBoisblanc (Idaho Nuclear Corp., Idaho Falls), from French report MIN-82. 69p. Dep. CFSTI. JCL $7.60 fs, $2.48 mf.

A description of the ERMINE experiment being carried out in a fast reactor region in the central cavity of the MINERVE pile is presented. Subjects presented in the description include: configuration of experiment assembly; loading and subcritical approach; safety studies; critical conditions; reactivity effects; and assembly control and kinetics. (D.C.C.)

14264 LOW TEMPERATURE IN-PILE IRRADIATION FACILITIES. Nakai, Yasushi (Mitsubishi Atomic Power Industries, Inc., Omiya, Japan); Kumamoto, Hisashi. Mitsubishi Denki Lab. Rep., 41: 1517-21(Dec. 1967). (In Japanese).

The low temperature in pile-irradiation facilities (called LHTL), which were set up in a research reactor of the Japan Atomic Energy Research Institute in Dec. 1966, are described. The facilities comprise a closed type He liquifier system having refrigerating capacity of 50 W, a cryogenic irradiation tube to irradiate test specimen with fast neutrons in liquid He temperature environment and specimen handling equipment to take outside the sample pieces held at very low temperature. The construction and functions of the principal parts and brief report on the erection at the site are given. (auth) (NSA of Japan)

14265 TEMPERATURES WITHIN A RECTANGULAR CHANNEL OF A NUCLEAR REACTOR. Lackme, Claude (Centre d'Etudes Nucleaires, Grenoble, France). Entropie, No. 17, 15-28(Sept.-Oct. 1967). (In French).

In the techniques used for cooling nuclear reactors, the existence of flux peaks in a great nuisance. The case is considered here of a fuel lattice made up of plates and thus giving rectangular cooling channels. A theoretical and practical study has been made of transverse heat exchange in this structure. An example is given of an application which is in the form of a calculation of the temperature distributions at the exit of a cooling channel of the swimming-pool type reactor SILOE operating at 10 MW. (auth)

14266 EXPERIMENTAL REACTOR WITH GASEOUS UF_6. NO. 2. THE CALCULATION OF SHIELDING AND HEAT BALANCE. Ogushi, Terumune (Chuo Univ., Japan); Yumoto, Ryozo. Chuo Daigaku Rikogakubu Kiyo, 8: 134-50(Dec. 1965). (In Japanese).

The shielding thickness of the core of the experimental reactor with gaseous UF_6(1kW out-put) and the heat balance at 80°C determined. The primary γ-rays were divided into four groups, 1, 3, 5, and 7 MeV, and a calculation was made to each group. The side and top concrete thickness of the reactor was determined within the total attenuated γ-rays, less than M.P.D. 100 m·rem/week. The result was that the side and top shielding thickness of ordinary concrete was 168 cm and 161 cm, respectively. In such an atomic reactor as of 1 kW out-put, the shielding thickness that is satisfactorily able to attenuate primary γ-rays, has inevitably a nature to attenuate fast neutron, thermal neutron and secondary γ-rays. The shielding thickness of 200 cm concrete was enough to shield γ-rays and other radiation when the reactor was operated at 1 kW. The experimental reactor requires about 5 kW to hold the core temperature at 80°C. (auth) (NSA of Japan)

14267 EXPERIMENTAL REACTOR WITH GASEOUS UF_6. NO. 1. THE CALCULATION OF THE CRITICAL MASS. Ogushi, Terumune (Chuo Univ., Japan); Yumoto, Ryozo. Chuo Daigaku Rikogakubu Kiyo, 8: 125-33(Dec. 1965). (In Japanese).

The critical mass of experimental reactor with gaseous UF_6 is determined. The reactor was a partly heterogeneous type, with a Be metal moderator and a graphite reflector. The core of the reactor was of cylindrical shape, 116 cm in diameter and 108 cm height. The Be moderator was in the form of tubes of 4.0 cm square in cross-section. Gaseous UF_6 was filled in 148 channels arranged in a square lattice with 8.0 cm pitch. Aluminum tubes of 4.0 cm square in cross-section and 0.1 cm thick were used to make those channels. The side reflector was 50.0 cm thick, and the upper and the lower reflectors were both 60.0 cm thick. From the results of the calculation by one-group theory of four factor formula, it was shown that the reactor can reach critical mass with that of 2.3 kg 90% enriched UF_6 at 0.9 atm. and 80°C. (auth) (NSA of Japan)

14268 THE DETERMINATION OF THE SPATIAL DISTRIBUTION OF THERMAL NEUTRON SPECTRUM IN $U_{nat}O_2-H_2O$ LATTICES BY INTEGRAL METHODS. Albert, D.; Schumann, P. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 10: 269-71(Sept. 1967). (In German).

Using Lu, Eu, Dy, and Cu activation foils, the spatial distribution of spectrum indices was measured in a $U_{nat}O_2-H_2O$ lattice. Measurements within the annular core of the Rossendorf zero-power reactor RRR were made both for the undisturbed lattice, and in presence of disturbances characterized by substituting several elementary cells by H_2O or Cd. The spectrum indices measured have been evaluated with respect to the spectrum

parameters on the basis of two spectrum models. Foil measurements which integrate over the moderator and fuel regions of one elementary cell gave information about spectrum parameters and the disadvantage factor. 11 references. (auth)

14269 FAST FISSION RATIOS IN NATURAL URANIUM CLUSTER HEAVY WATER LATTICES. Maracci, G.; Rustichelli, F. (EURATOM, Ispra, Italy). J. Nucl. Energy, 21: 857-65(Nov. 1967).

The ratio δ^{28} of ^{238}U fissions was measured for 19-rod cluster fuel elements in D_2O-moderated lattices; the fuel composition was natural uranium metal. The experimental results were obtained by comparing the activations of depleted and natural uranium foils after irradiating them inside the fuel assemblies and by determining the calibration factor P(t) by a back-to-back fission chamber. The experimental values are compared with theoretical calculations. (auth)

14270 EPITHERMAL AND THERMAL SPECTRUM INDICES IN HEAVY WATER LATTICES. Sokolowski, Evelyn K.; Jonsson, A. (Aktiebolaget Atomenergie, Studsvik, Sweden). J. Nucl. Energy, 22: 27-51(Jan. 1968).

Spectral indices were measured by foil activation technique in a number of different D_2O-moderated lattices in the Swedish zero power reactor R0 and the pressurized exponential assembly TZ. In most cases the fuel was in the form of single rods, distributed uniformly in the lattice. Parameters in these cases were lattice pitch and fuel composition. A 31-rod cluster lattice was also investigated, with the moderator temperature varying up to 210°C. On the basis of these measurements, as well as measurements on cluster lattices reported by other investigators, simple correlations were derived for the spectral indices, which seem to be of fairly general validity for D_2O lattices. The experimental results were also compared to calculations with the multigroup collision probability program FLEF. (auth)

14271 CROSS-SPECTRAL DENSITY MEASUREMENTS IN A COUPLED-CORE REACTOR. Hendrickson, Richard A.; Murphy, Glenn (Iowa State Univ., Ames). Nucl. Sci. Eng., 31: 215-21(1968).

A method is developed to determine the ratio of the reactivity coupling coefficient to the mean generation time in a two-slab reactor based on experimental measurements of the inherent reactor-noise spectrum. A matrix formulation of the cross-spectral density function of the fluctuating neutron density at two experimental access locations adjacent to the cores is used in conjunction with a two-point reactor model to show that the real part of the cross-spectral density vanishes at a particular frequency, termed the sink frequency. The sink frequency is a function of the ratio of the reactivity coupling coefficient to generation time in the cores and the times required for neutron disturbances to travel between the cores and the detector locations. Experimental results from the UTR-10 reactor verify the predicted behavior of the cross-spectral density function in the neighborhood of the sink frequency and provide an at-critical measurement of the reactivity coupling coefficient. 7 references. (auth)

14272 MANUFACTURE OF FUEL FOR SECOND CHARGE OF KYOTO UNIVERSITY REACTOR. Ishida, Ryuichi; Tetsuya, Teruo (Sumitomo Electric Industries, Ltd., Osaka). Sumitomo Denki, No. 95, 73-81(May 1967). (In Japanese).

Since the completion of the reactor in 1964, Research Reactor Institute of Kyoto University has been operating with imported atomic fuel. However, they decided to use also Japan-made fuel for the second and subsequent charges. Sumitomo Electric manufactured 40 fuel elements for one reactor core and delivered them to the Institute. This fuel element is a plate type fuel consisting of 90% enriched U–Al alloy plate sandwiched between Al plates. The manufacture of the fuel is described in detail. (auth) (NSA of Japan)

14273 CRITICAL STUDY OF BeO BY PULSED NEUTRON METHOD. Joshi, B. V.; Nargundkar, V. R.; Subbarao, K. (Bhabha Atomic Research Centre, Trombay, India). J. Nucl. Energy, 21: 883-92(Dec. 1967).

In a critical study of the decay of the thermal neutron population in BeO assemblies of bucklings beyond $(B^2)^*$, it was observed that the decay is exponential and that a single decay constant can be assigned for each buckling. The buckling range investigated was from 0.0028/cm² (100 × 100 × 100 cm³) to 0.0592/cm² (20 × 20 × 20 cm³). In the calculation of the buckling the variation of transport mean free path with energy was taken into account. It was observed that the estimation of the diffusion parameters is not sensitive to the variation of the transport mean free path with energy. It was possible to make a cubic fit, and a positive B^6 coefficient was obtained. The diffusion parameters obtained for constant λ_{tr} were: $A_0 = \Sigma_a\nu = (141.33 \pm 4.13)$/cm, $D_0 = (1.38 \pm 0.01) \times 10^5$ cm²/sec, $C = -(8.44 \pm 0.69) \times 10^5$ cm⁴/sec, $F = (5.54 \pm 1.02) \times 10^6$ cm⁶/sec, $L = (31.3 \pm 0.5)$ cm, $\lambda_{tr} = (1.66 \pm 0.02)$ cm. The results are conditional on $(B^2)^*$ being about 0.03/cm². (auth)

14274 MEASUREMENT OF THERMAL NEUTRON FLUX DISTRIBUTIONS AND OF THE r FACTOR IN AN $U_{nat}O_2$–H_2O LATTICE AND THEIR COMPARISON WITH THE RESULTS OF MULTIGROUP DIFFUSION CALCULATIONS. Albert, D.; Faehrmann, K.; Schumann, P. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger). Kernenergie, 10: 243-7(Aug. 1967). (In German).

Activity measurements in unperturbed and perturbed $U_{nat}O_2$–H_2O lattices within the annular zone of the RRR reactor have been carried out. The measured distributions of the thermal and epithermal neutrons are compared with the results of a three-group and a 26-group diffusion calculation. (12 references). (auth)

14275 FUEL ELEMENT FOR EXPERIMENTAL NUCLEAR REACTORS. Planquart, J.; Herpin, J. (to Centre d'Etude de l'Energie Nucleaire). Canadian Patent 766,337. Aug. 29, 1967. Priority date Sept. 6, 1962, Netherlands.

A fuel assembly for an experimental reactor is described which consists of several plates joined edge-to-edge by radially-located lengthwise braces so as to form coaxial tubes. Other features are brace extensions and a ring for joining the extensions at the ends. A special taper is provided in the ring portion to prevent disturbance of the coolant flow. High flux irradiation of a sample placed in the hollow center of a fuel element is possible. (F.S.A.)

14276 WARM-WATER LAYER STABILIZING DEVICE FOR A SWIMMING POOL TYPE REACTOR. Yoshiyanagi, Kiyami (to Hitachi Ltd.). Japanese Patent 1966-12958. June 18, 1966. Filed Jan. 21, 1963.

The warm-water layer stabilizing device is used in a swimming-pool type reactor where the reactor-core tank is divided into a top warm-water layer and lower layer cooling water; the top layer prevents the rising to the surface of contaminated cooling water. The reactor core is placed on the bottom of the reactor core tank. "Auxiliary" warm water is supplied to the warm-water layer from a heated warm water tank. Cooling water is circulated through the tank and core, through an external heat-exchanger by means of a pump, entering the tank at the middle of the tank length and leaving it from the bottom; the tank can be replenished with fresh cooling water. A cooling water "overflowing" system is provided outside the tank, connecting to the cooling water in the tank. When the level of the warm-water layer exceeds a given level, the overflowing tank at the end of the system discharges the amount of cooling water corresponding to the rise in the level of the warm-water layer. (NSA of Japan)

14277 START-UP OF A SWIMMING POOL TYPE REACTOR. Yamanouchi, Atsuo (to Hitachi Ltd.). Japanese Patent 1966-11959. June 30, 1966. Filed June 22, 1963.

In the method of swimming-pool type reactor start-up which is proposed, before the startup, part of the (circulating) cooling water is drawn out in order to increase the thickness of warm water below the heater; then the reactor operation is started. (NSA of Japan)

14278 REACTOR CONTROL MECHANISM. Mizuno, Katsuhiro (to Hitachi Ltd.). Japanese Patent 1966-3596. Mar. 2, 1966. Filed Jan. 21, 1963.

The reactor control mechanism proposed is so constructed that when the reactivity is increased due to the insertion or removal of an irradiation sample with regard to the reactor core, the safety shut-down cannot be actuated. A relay device is provided in the overall control mechanism which operates during the insertion or removal of a sample material and does not permit the insertion of a safety control rod for this period of time. (NSA of Japan)

14279 SWIMMING POOL TYPE RESEARCH REACTOR. Matsumoto, Seikichi (to Hitachi Ltd.). Japanese Patent 1966-12959. June 18, 1966. Filed Mar. 19, 1963.

In the swimming-pool type research reactor proposed, the handling of the high-flux region can be done from the outside, even when the reactor is in operation; experiments in very high neutron fluxes, as well as experiments in an ordinary swimming-pool type reactor can be conveniently performed. A pressure vessel, for the forced cooling-water circulation, is installed in the reactor pool; the reactor core is settled on the bottom of this vessel. The reactor core is so constructed that along the central line of it a guide into the high neutron-flux region can be installed instead of fuel. A hole is made in the top of the pressure vessel, at the position just above the guide in the core. By means of this arrangement, the guide (sleeve) and an irradiation loop can be installed in position or removed conveniently. (NSA of Japan)

14280 REACTOR CORE TANK. Aizu, Tadashi (to Hitachi Ltd.). Japanese Patent 1966-14076. June 30, 1966. Filed Nov. 21, 1963.

An improved core tank is proposed which separates the primary cooling-water (in the core tank) from the secondary cooling water (in the pool) in a swimming-pool type reactor. Using this core tank, the level of the primary cooling-water and of the secondary cooling-water can be adjusted with respect to each other both easily and automatically. A hole is cut through the wall (near the bottom) of a bottom-closed cylindrical body which forms the core tank. This hole acts as a sort of valve for adjustment of the cooling-water levels. A valve seat is fixed around this hole on the inside of the cylindrical body. A round plate closes this hole from the inside in the manner of an ordinary plug. This plate is supported in position by means of a handle attached to it; the other end of this handle is held rotatable to the seat. The round plate is pressed against the seat or hole by means of a weight embodied with the plate and its handle. The balance between the pressure to the cover plate from the secondary cooling-water side and from the primary cooling-water side is utilized for the automatic adjustment of the cooling-water levels. (NSA of Japan)

14281 NEUTRON DIFFRACTION EXPERIMENTAL APPARATUS FOR A NUCLEAR REACTOR. Ono, Yoshihisa (to Japan Atomic Energy Research Inst.). Japanese Patent 1967-3759. Feb. 16, 1967. Filed Feb. 21, 1963.

By the method proposed, the following advantages are obtainable: the 10 to 100 fold increase of the monochromatic neutron-radiation intensity; the consequent reduction of the measuring time and increase of the measurement accuracy; the possibility of experiments with a low power reactor; elimination of the massive shield and simplification of the overall construction; and the far easier change of the energies of the monochromatic neutron radiation. It includes: the experimental hole (in the nuclear reactor); a neutron-velocity selector (installed in the experimental hole); a goniometer; and a neutron detector. The neutron-velocity selector is of a cylinder and is rotated in the experimental hole; a spiral thin groove is cut on the surface of the cylinder from one end to the other. (NSA of Japan)

14282 DEVICE FOR ADJUSTING THE WATER LEVEL OF A NUCLEAR REACTOR. Haneda, Mikio (to Nippon Atomic Ind. Group Co., Ltd.). Japanese Patent 1967-2079. Feb. 7, 1967. Filed Aug. 16, 1962.

The proposed device is used for adjusting the water level of a light-water, critical experiment reactor. The reactor core is in the (water) tank filled with light water both as moderator and reflector, and various physical constants are measured. In order to maintain the high accuracy of the experiment, the water level in the tank must be kept at a constant value. This is effectively achieved by the proposed method. The "first" water tank filled with water of a specific temperature, containing the reactor core; the "second" water tank in which a "volume" rod (to displace water) moves up and down in the upper part of pool water; a pipe, connecting the two tanks by their bottom, which has an adjustable orifice within it; a float to detect the water level in the first tank; a servo-amplifier, which produces an output corresponding to the fluctuation in the water level, by means of a signal from the float; and an electric motor, energized by the output, which introduces or withdraws the volume rod in the second water tank. The cross-sectional area of the orifice is at the threshold (or lower) beyond which disturbance is caused in the level adjustment by the volume rod. (NSA of Japan)

14283 REACTOR CONTROL ROD. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1966-12159. July 5, 1966. Filed Sept. 30, 1963.

An improved control rod is proposed which absorbs neutrons for control of research reactors. The control rod is made of a cylindrical body with a central tube located axially. The tube contains a mixture of neutron moderator and fast-neutron absorber. Surrounding this central tube are arranged a number of tubes (also in the axial direction), containing a mixture of epithermal-neutron absorbers. Surrounding this arrangement and in contact with the inside surface of the cylindrical body are arranged axially a number of tubes, containing a mixture of strong thermal-neutron absorbers. (NSA of Japan)

14284 SIPHON BREAKER FOR A NUCLEAR REACTOR. Yoshiyanagi, Kiyomi (to Hitachi Ltd.). Japanese Patent 1966-22400. Nov. 8, 1966. Filed Jan. 21, 1963.

The siphon breaker proposed makes possible the safe operation of a swimming-pool type reactor by preventing the temporary lowering of water level due to a water hammer. The core tank with a reactor core is installed in the water pool; the piping for coolant circulation runs through the core and heat-exchanger. The piping, outside the core tank, has a rise, runs horizontally, and goes down to the heat exchanger. A vent pipe, leading to the atmosphere, is installed onto the level part of the piping; and at a suitable position of this vent pipe is a valve. This valve is opened or closed, according to the velocity of water flow through the circulation piping. (NSA of Japan)

14285 MEASUREMENT OF SHUTDOWN MARGIN. Pedersen, Knud Borge. Ames, Iowa, Iowa State Univ. of Science and Tech., 1967. 79p.
Thesis.

A method for direct measurement of the shutdown margin is developed; the method is verified, experimentally, using the UTR-10. Measurements are given for conditions ranging from almost critical to fully shut down. Experimental techniques and equipment are described. (TSS)

14286 IRRADIATION DEVICE IN AN IN-PILE LOOP. Aoki, Naoji (to Hitachi Ltd.). Japanese Patent 1966-14400. July 4, 1966. Filed May 6, 1963.

The irradiation device proposed is used for irradiating a sample material with neutrons from the reactor core, within a tube installed in the experimental hole. The sample material, attached to the top of the sample holding rod, which extends into the reactor, is surrounded with a cylindrical neutron absorber. This cylindrical body can move, forward and backward, by means of the horizontal rod (at the top of which the cylindrical body is attached) and the pinion and rack (at the other end of the horizontal rod). A neutron absorbing plate, which falls flat or rises upright, is installed in front of the sample material. This falling or rising of the plate is achieved by the pinion and rack attached to the end of an extension of the horizontal rod. The whole mechanism (or more exactly the back and forth movement of the horizontal rod) is done by means of an electric motor installed just outside of the reactor. (NSA of Japan)

14287 PULSED NUCLEAR REACTORS. Hanke, Wilhelm (to European Atomic Energy Community). U. S. Patent 3,359,171. Feb. 10, 1966. Priority date Feb. 15, 1965, Belgium.

The description of a rotating disk pulsing device for a pulsed reactor is presented. The rotating disk is located on a threaded drive shaft with screwthreads coaxial with the axis of disk rotation. A breakable driving member secures the disk to the threaded drive shaft. If drive shaft motion ceases, the momentum of the disk relative to the shaft allows the disk to continue rotation by running along the screwthreads. (TSS) (U.S. Pat. Gazette)

Production Reactors

Refer to abstracts 12398 and 14142.

Reactor Theory, Components, Fuels and Accessories

Refer also to abstracts 12476, 12488, 12494, 12500, 12568, 12570, 12670, 12671, 12954–12958, 12962, 12995, 12999, 13036, 13044, 13049, 13057, 13060, 13063, 13070, 13900, 13904, and 13905.

14288 (AAEC/E-184) CALCULATION METHODS FOR MULTIGROUP NEUTRON CROSS SECTIONS USED IN BURNUP STUDIES. Pollard, J. P. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct. 1967. 49p. Dep.
Thesis. Submitted to Univ. of New South Wales, Kensington, Australia.

Calculation of burnup of material composing a nuclear reactor is important in a feasibility study of lifetime of fuel in possible reactor systems. Discussed are: (i) a basis for calculating a flux spectrum in order to obtain multigroup cross sections, and (ii) a method for solving the burnup equations. Under (i) particular attention is paid to the calculation of multigroup resonance cross sections and (ii) a simple and effective analytic technique is derived. Developments in the field of reactor physics which effect the calculation of multigroup data are presented. The physical model adopted to simplify the otherwise unmanageable equations is appropriate to a large recirculating fuel reactor operating under equilibrium conditions. The work is divided into essentially three parts (i) the basis of multigroup data, (ii) the calculation of multigroup data, and (iii) the solution of burnup and multigroup flux equations. Considering that neutron reactions are very dependent on neutron energy it is convenient to divide the energy range into three regions typified by completely different behavior. These are (a) the fast region—neutrons are produced from fission, (b) the resonance region—neutrons slow down in energy, and (c) the

thermal region neutrons scatter up and down in energy until lost. (auth)

14289 (BNWL-635) PHOENIX FUEL PROGRAM PROGRESS REPORT. Lanning, D. D.; Busselman, G. J. (eds.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1967. Contract AT(45-1)-1830. 132p. Dep. CFSTI.

REACTOR FUELS — neutronics characteristics of Phoenix; cycle economics for Phoenix fuels for marine reactors; burnup measurements of Phoenix; burnup calculations for MTR-Phoenix; design variations of, effects on core burnup reactivity on

REACTIVITY — calculations for Phoenix fuels for marine reactors; temperature coefficient of, effects of Phoenix fuel on PRTR

NEUTRONS — multiplication factor calculations for Phoenix fuels for marine reactors; flux calculations for HFIR, use of Phoenix fuels in

PLUTONIUM RECYCLE TEST REACTOR — Phoenix fuel loadings for, lattice characteristics of; Phoenix fuels for, variation of effective neutron multiplication with enrichment of; criticality calculations for, effects of using Phoenix fuels on; core lifetime for, use of Phoenix fuels in calculations of

REACTORS MARITIME — Phoenix fuels for, reactivity and multiplication calculations using

ORNL HIGH FLUX ISOTOPE REACTOR — Phoenix fuels for, feasibility of use of; Phoenix fuels for, fabrication of

PLUTONIUM — use as fuel, comparison of uranium and; fuels of, economics of; isotopic variations in MTR-Phoenix zoned core loading of fuel elements of

CRITICAL ASSEMBLIES — Phoenix fuels in, burnup measurements of

PLUTONIUM RECYCLE CRITICAL FACILITY — Phoenix fuel elements in, power distributions in

REACTOR FUEL ELEMENTS — design of Phoenix; fabrication of Phoenix

REACTOR CONTROL ELEMENTS — design of Phoenix; fabrication of Phoenix

MATERIALS TESTING REACTOR — Phoenix fuel elements for, mechanical design of; core for, Phoenix fuel loading for; power distribution in, effects of Phoenix fuels on; core for, thermal hydraulics of Phoenix; core parameters for, comparison of regular and Phoenix (M.L.S.)

14290 (BNWL-SA-1513) REACTOR PHYSICS MONTE CARLO APPLICATIONS. Thomsen, D. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 20, 1967. Contract AT(45-1)-1830. 32p. Dep. CFSTI.

Uses of Monte Carlo methods for reactor physics calculations are discussed; available computer codes are described. The codes are then listed by application. 102 references. (M.L.S.)

14291 (CEA-R-3327) INTRODUCTION A L'ETUDE DE L'EBULLITION DANS LES REACTEURS A EAU. (Introduction to the Study of Boiling in Water Reactors). Froelicher, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 12p. (In French). Dep.

In order to plot the low- and high-power transfer function for a reactor using its background, a conventional method is proposed for estimating the efficiency of a CC5 chamber connected to a direct current detection system. (auth)

14292 (CEA-R-3333) AMELIORATION DE L'INSENSIBILITE AUX PARASITES DES AMPLIFICATEURS D'IMPULSIONS. (Improvement in the Insensitivity of Pulse Amplifiers to Interference). Buisson, Jacques; Garau, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 11p. (In French). Dep.

The level of background noise around certain reactors is often so great that the operation of pulse assemblies is strongly affected. A few practical precautions are described which make it possible to decrease and sensitivity to parasitics. Results obtained on two reactors, G 1 and AQUILON, are described. (auth)

14293 (DP-1121) COMPUTER CODES FOR NUCLEAR CRITICALITY SAFETY CALCULATIONS. Clark, Hugh K. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Nov. 1967. Contract AT(07-2)-1. 88p. Dep. CFSTI.

Several computer codes for nuclear criticality safety evaluations are described along with their input requirements. The two basic codes are a code for computing the buckling of fissile material and a two-group diffusion theory code, which uses parameters calculated by the buckling code, for computing critical sizes. The other codes generate cross sections for the buckling code, modify two-group parameters for special cases, compute k_{eff}, and compute the effect of special shapes. Numerous correlations of the codes with data obtained in exponential and critical experiments are given to permit the user to determine the margin that must be allowed to ensure subcriticality for various situations to which the codes may be applied. (auth)

14294 (ORNL-4198) BEHAVIOR OF OXIDE AEROSOLS OF URANIUM AND STAINLESS STEEL IN HUMID ATMOSPHERES. Yuille, W. D.; Adams, R. E. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 43p. Dep. CFSTI.

Laboratory experiments were made to examine the effect of moisture on aerosols produced by arc-melting simulant reactor fuel in air. The only simulant used was stainless steel clad UO_2. An effect of moisture was obtained by either generating the aerosol in 80 to 90% relative humidity air or by bubbling the dry generated aerosol through water. Analysis of samples taken with thermal precipitators and by fibrous filter analyzers showed that the presence of moisture does affect both size and shape of aerosol agglomerates. A marked reduction in filtering efficiency of the wet aerosol was measured through open structure roughing filters. Humidity does not bring about physical changes by operating on the electrical charge properties of the aerosol. A chemical reaction between water vapor and the constituents of the aerosol agglomerates initiates the changes in particle size and shape observed. (auth)

14295 (RISO-162) HEAT TRANSFER BY ORGANIC COOLANTS. Kaiser, N. E. (Danish Atomic Energy Commission, Risoe. Research Establishment). Aug. 1967. 33p. Dep.

The heat transfer characteristics of organic coolants were investigated in an out-of-pile experiment. A description of the experiment and the measurements carried out is given. The results show that the heat transfer coefficient for a smooth rod in an annulus can be predicted by means of the formula $Nu = 0.0094 Re^{0.88}Pr^{0.4}$ with a standard deviation of about 10% in the forced-circulation region. The above formula is compared with some other similar formulae and shows good agreement in the range of Reynolds' number investigated. (auth) (Denmark)

14296 (RPI-328-100, pp 140-87) REACTOR PHYSICS: THEORETICAL. (Rensselaer Polytechnic Inst., Troy, N. Y.).

Using nuclear data intended for fast reactor large oxide cores, the inverse moderating ratio and the fission-to-absorption ratio were correlated and the adjoint spectrum was evaluated. A preliminary analysis of a large carbide core was also made using the same data. The cross section correlations and the comparison of analytic and multigroup adjoint spectra are shown for the carbide system. The possibility of using semidirect least-squares variational methods for initial-value problems in fast reactor analysis is examined. Static tilt test problems using Green's function modes and variational methods were performed for test reactors consisting of bare slabs of varying thicknesses containing monoenergetic neutrons. Directional and scalar fluxes as a function of hole depth are presented in an examination of re-entrant hole perturbation effects in water. The time dependent equation for the slowing down of a fast neutron pulse in a finite hydrogenous medium was studied. The problems of Doppler broadening of p-wave and s-wave neutron resonances were formulated and examined. A theoretical study of time moments for thermal neutrons was initiated using a single relaxation time model. Results obtained using a model for the analysis of time dependent neutron transport are presented. The accuracy of the importance-shape method for determining the geometric buckling in reflected reactors is investigated. (H.D.R.)

14297 (WAPD-T-1955) DIRECT MEASUREMENT OF THE SHUTDOWN REACTOR ASYMPTOTIC EIGENVALUE. Walter, J. F. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1967. Contract AT(11-1)-Gen-14. 13p. (CONF-670602-11). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

The asymmetry source experiment for measuring the asymptotic eigenvalue of a shutdown reactor or critical assembly is described. Calculations are given. Possible use as a reactivity meter is hypothesized. (M.L.S.)

14298 (ANL-Trans-555) RESEARCH ON THE DESIGN OF EXPLOSION PROOF CONTAINMENT STRUCTURES. (Japan Atomic Energy Research Inst., Tokyo). Translation of report JAERI-Memo-1896. 223p. Dep. CFSTI. JCL $15.00 fs, $6.89 mf.

Results of explosion testing of four steel-reinforced concrete structures are given. Descriptions of the structures are presented; explosives used for testing are described. Blast-induced pressures are given; structural response is shown; examinations of deformations and cleavages are discussed. (M.L.S.)

14299 STUDIES ON THE PRESSURE DROPS OF THE TWO-PHASE FLOW IN THE VERTICAL PIPES. Inoue, Akira (Tokyo Inst. of Technology). Tokyo Kogyo Daigaku Gakuho, No. 76, 139-42(Mar. 1966).

The experimental formula necessary for a gas-liquid two-phase flow plant design, starting from the fundamental consideration for the flow behavior and various flow conditions, is presented. It consists of the following: fundamental consideration on the pressure drop of the two-phase flow; experiment on the pressure drop of two-phase flow in vertical pipes; the two-phase flow in pipes with an annular channel, cluster pipes and other shape pipes; the two-phase flow where bubbles form along the pipe wall; the acceleration two-phase flow in pipes with an annular channel and cluster pipe; and discussion on the analytical method by use of an energy dissipation equation. (NSA of Japan)

14300 NEUTRON DIFFUSION ACROSS A TEMPERATURE DISCONTINUITY IN CRYSTALLINE MODERATORS. Trikha, S. K.; Goyal, I. C.; Kothari, L. S.; Ghatak, A. H. (Delhi Univ.). J. Nucl. Energy, 21: 811-32(Nov. 1967).

Calculations on the diffusion of neutrons across a temperature discontinuity in crystalline moderators, graphite and Be, are reported. Using plane geometry, with the first slab of finite thickness and the second slab extending to infinity, the steady-state neutron spectra were calculated at different space points. The space variation of total neutron density, and also the space variation of average neutron energy, were studied. Defining the effective temperature T_{eff}, as $T_{eff} = (2/3k) \times$ (average energy) (where k is the Boltzmann constant) the results for graphite were compared with the experimental data of Coates and Gayther (1961), Day and Partridge (1964), and Day (1967). The agreement is good except near the interface, and it is shown that this discrepancy is most probably due to the fact that the steady-state neutron spectra are not Maxwellian and therefore the calculated value of the effective temperature depends upon the way it is defined. (auth)

14301 A METHOD OF TRANSFORMING THE PROMPT DECAY CONSTANT α_i INTO THE STATIC REACTIVITY ρ_s. Sunako, Katsuhiro; Amano, Fumio. Denki Shikensho Iho, 31: 1051-63 (1967). (In Japanese).

An analytical method of transforming the prompt decay constants α_i into the static reactivity ρ_s is given. It has been developed through the use of the time-dependent, two-group diffusion theory ignoring delayed neutrons under several assumptions. A generalized characteristic equation which relates the prompt decay constants to the effective multiplication constant can be generally derived by expanding the static fluxes which contain the fundamental and higher modes. Several approximated formulas for this equation have been obtained under certain conditions. A formula which takes into account the change in the generation time is proposed as one of the most useful methods for reactivity measurements. Error evaluation has been performed in regard to several approximate formulas, and some problems involving numerical calculation have been investigated. (auth)

14302 OPTIMAL CONTROL OF NUCLEAR REACTOR SYSTEMS. Wiberg, D. M. (Univ. of California, Los Angeles). Advan. Contr. Syst., 5: 301-88(1967).

A review (82 references) is presented which includes a discussion of the point reactor model, reactor kinetic state equations, linearized state equations and 2 methods of their solution, methods of solution of the Kaplan modes, a method of estimating the effects of spatial variation on stability, and analytical design of a spatial feedback control system. Methods for attacking the description and control of most reactor spatial processes have been investigated. It was shown that any locally unstable process can lead to a spatial instability, and this possibility can be investigated by the methods described. The concept of the temperature coefficient of reactivity was extended so that spatial temperature effects can be investigated by their inclusion in the general model. A discussion of the control of the infinite mode system was given. Possible further work on the infinite mode control problem was indicated. (TSS) (BBB)

14303 PHOTOELASTIC ANALYSIS OF STRESSES AT SKIRT-SUPPORT JUNCTIONS OF NUCLEAR PRESSURE VESSEL MODELS. Kono, K.; Ono, T. (Mitsubishi Heavy Industries, Ltd., Omiya, Japan). Mitsubishi Juko Giho, 4: 451-8(Sept. 1967). (In Japanese).

The results of photoelastic analysis of stresses at the skirt-support junctions of nuclear pressure vessel models are presented. A two-dimensional photoelastic test was carried out on the configuration of the skirt-support junctions of model vessels, and a configuration which was desirable from stress viewpoint was chosen after parametric study. A three-dimensional photoelastic test was conducted on the models, and stress distribution in each component part under internal pressure, vertical and horizontal loads was investigated. The maximum stress was found on the outside and inside parts of the skirtshell junctions and on the outside of the skirt. Numerical calculation examples are presented to illustrate the analysis by shell theory and matrix method. (auth)

14304 NUMERICAL SOLUTION OF THE TIME-DEPENDENT MULTIGROUP DIFFUSION EQUATIONS. Andrews II, J. Barclay; Hansen, K. F. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng., 31: 304-13(1968).

A numerical method for the solution of the time-dependent multigroup diffusion equations is presented. The method has the property that it is numerically unconditionally stable for all changes in reactor properties and all integration time-step sizes. The method assumes that the neutron flux and precursor concentration can be expressed on an exponential function over each time step. As a result of this assumption, and the factoring of the matrix form of the multigroup equations, it is shown that for the case of a constant step change in the properties of the system the asymptotic numerical eigensolution is proportional to the asymptotic eigensolution of the differential equations. An analysis of the truncation error associated with the method is also presented. Finally, a number of numerical experiments are presented which illustrate the accuracy, speed, and general utility of the method. (auth)

14305 STRATEGY FOR THE APPLICATION OF SPACE-ANGLE SYNTHESIS TO PRACTICAL PROBLEMS IN NEUTRON TRANSPORT. Natelson, M. (Bettis Atomic Power Lab., West Mifflin, Pa.). Contract AT(11-1)-gen-14. Nucl. Sci. Eng., 31: 325-36(1968). (WAPD-T-1986).

A strategy is proposed for the application of space-angle synthesis (SAS) to the finding of solutions for practical nuclear reactor neutron transport problems. A simple SAS approximation is derived. Trial functions for the approximations are to be created for each mesh point used in describing a set of similar problems which are to be solved. The strategy is concerned with constructing problems that are simpler than, but representative of, the set of problems finally to be solved. It is from transport solutions of these representative problems that the SAS trial functions are to be formed. This strategy and the simple SAS approximation are applied successfully to several sets of similar problems for which diffusion theory is inadequate. (auth)

14306 MONOENERGETIC CRITICAL PARAMETERS AND DECAY CONSTANTS FOR SMALL HOMOGENEOUS SPHERES AND THIN HOMOGENEOUS SLABS. Carlvik, I. (Aktiebolaget Atomenergi, Stockholm). Nucl. Sci. Eng., 31: 295-303(1968).

A method has been developed for the solution of the monoenergetic critical problem for a slab or a sphere. The method utilizes an expansion of the flux density in Legendre polynomials of the coordinate. It is equivalent to the usual variational method using powers of the coordinate, but the use of Legendre polynomials makes it possible to calculate most of the elements of the resulting matrix by means of recurrence formulae. A series of calculations has been performed for slabs and spheres with $|\tilde{d}| \leq 5$, where $\tilde{d}$ is the thickness of the slab or the diameter of the sphere measured in mean-free-paths. The critical problem is equivalent to the problem of determining the decay constant of a subcritical system with an exponentially decaying flux density. The calculations also give a series of decay constants for subcritical slabs and spheres. Comparisons with diffusion theory show that large errors can result from uncritical application of diffusion theory to small assemblies. The results of the calculations show clearly the interesting fact that the exponentially decaying flux of very small spheres has a minimum at the center. 17 references. (auth)

14307 MONTE CARLO ANALYSIS OF NUCLEAR REACTOR FLUCTUATION MODELS. Zolotar, Burt A. (Cornell Univ., Ithaca, N. Y.). Nucl. Sci. Eng., 31: 282-94(1968).

The one-mode stochastic nuclear reactor model has been proposed by Bell to study fluctuations in neutron populations. The purpose of this model is to allow consistent space and energy corrections to point reactor stochastic results. The model has been extended to also cover fluctuations in captures and fissions. A time-dependent, Monte Carlo computer program has been developed to simulate these fluctuations for a one-velocity bare reactor system and to estimate parameters of the probability distributions. It has been shown that the one-mode model for neutron populations and captures gives excellent agreement with the Monte Carlo results. Both showed a correction of about 50% to the magnitude of the variance predicted by basic point reactor equations. The fission probabilities required a more careful examination, but the Monte Carlo results could be predicted by approximate solutions to the exact stochastic equations. The in-

fluence of spatial effects on the properties of persisting and non-persisting chains in supercritical systems has also been examined. The one-mode model provides important corrections. 17 references. (auth)

14308 ENERGY OPTIMAL XENON SHUTDOWN. Lewins, Jeffery; Woodcock, Gordon R.; Williamson, Theodore J.; Babb, Albert L. (Univ. of Washington, Seattle). Nucl. Sci. Eng., 31: 272-81(1968).

Pontryagin's optimum theory is applied to the problem of determining a flux shutdown program that limits xenon poisoning in a reactor while using the minimum nuclear energy or flux time. The analysis shows several points of difference from the time-optimal problem. Solutions are found for both the unrestricted problem and the problem where the xenon density is restricted within the control period to some maximum acceptable poisoning. The method of solution is new in utilizing a more straightforward optimum theorem and giving the full adjoint solutions. A full solution to the restrained problem shows that a free end-time optimum solution rises at zero flux to the xenon restraint value and follows this value to the target curve, ending the problem. Not only is the energy optimal problem of some practical interest but it makes an excellent illustration of the complications of the continuum solution in optimal control and the very practical need to consider only those solutions satisfying certain state restraints. 14 references. (auth)

14309 ANALYSIS OF PULSED FAST-NEUTRON SPECTRA IN MULTIPLYING ASSEMBLIES. Jenkins, J. D.; Daitch, P. B. (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Sci. Eng., 31: 222-33(1968).

A simple model is developed to describe the time-dependent neutron spectrum in pulsed systems whose decay may be dominated by either a fundamental or a pseudofundamental mode. Such systems include a large class of fast multiplying assemblies and thermal nonmultiplying assemblies. The simple mode provides qualitative understanding of the role played by the fundamental or pseudofundamental mode in the kinetic evolution of the time-dependent neutron flux and, when optimized by a variational principle, gives excellent quantitative descriptions of the flux for a wide range of systems. Trial functions are presented which, when adjusted with a suitable variational principle, provide a good estimate of the shape and decay rate of the dominant reproducing mode of such systems. The method works well for systems where a fundamental mode exists and is also applicable in the range where pseudofundamental mode behavior is observed. Eigenfunction eigenvalue solutions are obtained for the fast multiplying system GODIVA and these, together with similar solutions for beryllium, provide a basis of comparison for the variational methods. The investigation shows that care should be exercised in associating reactivity and period parameters with far subcritical systems because the flux shape is changing substantially and the major regenerative mode is not isolated when the eigenvalue associated with this mode lies in the continuum. In the farther subcritical region an example shows a complete lack of a single dominant mode. 19 references. (auth)

14310 ON THE PERTURBATION FORMULA FOR RATIOS IN CRITICAL SYSTEMS. Ribaric, M. (Inst. Josef Stefan, Ljubljana, Yugoslavia). J. Nucl. Energy, 21: 899-902(Dec. 1967).

Usachev (1964) derived by physical reasoning a perturbation formula for computing the changes in the frequency ratios of various processes in a critical reactor caused by a change in its composition. Lewins (1966) and Pomraning (1967) constructed analogous variational principles for this purpose. Fischer (1967) inferred an equivalent perturbation formula from the asymptotic behaviour of the perturbed critical reactor. Usachev's perturbation formula is derived mathematically via Brillouin–Wigner perturbation formula of quantum mechanics. (auth)

14311 EFFECT OF FIRST-FLIGHT NEUTRONS ON COUPLED REACTOR KINETICS BEHAVIOUR. Belleni-Morante, A. (Univ., Florence). J. Nucl. Energy, 21: 867-70 (Dec. 1967).

The kinetic behaviour of a reactor composed of two loosely coupled cores was studied. It was proved that first-flight neutrons coming from an external source in one of the two cores may have a considerable effect on the time behaviour of the other core. (auth)

14312 FUEL CYCLE IN NUCLEAR POWER STATIONS. Hildenbrand, Guenter. At. Strom, 13: 169-74(Nov.-Dec. 1967). (In German).

A general discussion on the nuclear fuel cycle is given. Requirements and availability of uranium, in the western world, are discussed. Cost/kg is shown as a function of enrichment. Fuel element production is discussed, starting with the UF_6 and following through to the final fabrication of the element. Recovery and reprocessing of fuel materials is discussed. (M.L.S.)

14313 THE MULTI-LAYER CPV [CONCRETE PRESSURE VESSEL] CONCEPT. Nucl. Eng., 12: 926-8(Dec. 1967).

The concept consists of a vessel with two multi-layer walls separated by a gap filled with demineralized cooling water. The advantages of separation of the unstressed inner thermal shield and the outer prestressed concrete load bearing shell are discussed. The construction of a $\frac{1}{5}$ scale vessel is described, on which an extensive testing programme is continuing. (UK)

14314 BUILDING BREATHING SPACE INTO A REACTOR CONTAINMENT VESSEL. Archer, John C. Power, 111: 116-17(Nov. 1967).

A method for constructing containment vessels for power reactors is given. The Oyster Creek containment vessel is used as an example. Possible materials are considered briefly. (M.L.S.)

14315 25 YEARS AGO: THE FIRST ATOMIC PILE. Goldschmidt, Bertrand (Commissariat a l'Energie Atomique, Paris). Energ. Nucl. (Paris), 9: 418-20(Nov. 1967). (In French).

A summary history of the efforts involved in the building of the first atomic pile, and production of the first chain reaction is given. (M.L.S.)

14316 SOME TOPICS FROM THE ACTIVITIES OF THE SPECIAL COMMITTEE ON REACTOR NOISE ANALYSIS. II. Nippon Genshiryoku Gakkaishi, 9: 455-80(Aug. 1967). (In Japanese).

The more important activities of the Special Committee on Reactor Noise Analysis of the Atomic Energy Society of Japan are presented. They relate to experimental work undertaken mainly prior to the 2nd Florida Symposium (1966). A review is presented of results obtained with the application of various techniques, such as frequency analysis, correlation technique, binary noise technique, Rossi-α method, Feynman-α method and P method, these experiments being undertaken in connection with studies on reactor parameters and stability. (auth)

14317 THE COLLISION PROBABILITY CODE: MINOS. Harper, R. G. (Rolls-Royce Ltd., Derby, Eng.). J. Nucl. Energy, 21: 767-85(Oct. 1967).

A method is developed to solve the energy-dependent transport equation with anisotropic scattering, by the method of collision probabilities, in cartesian geometry. The program MINOS has been written to produce the resulting collision probability matrices in a typical lattice cell. These are then inverted using other programs. The running time of the scheme is comparable with multigroup two-dimensional diffusion theory. Comparisons of the method with other theoretical techniques are reported. (auth)

14318 FLUX SYNTHESIS USING GREEN'S FUNCTION IN TWO-DIMENSIONAL GROUP DIFFUSION EQUATIONS. Kobayashi, Keisuke (Kyoto Univ.). Nucl. Sci. Eng., 31: 91-101 (1968).

The group diffusion equations in two dimensions are solved by assuming the separation of variables sectionally. Using one-dimensional Green's functions, the two-dimensional diffusion equations are transformed into two sets of one-dimensional three-point difference equations at fine-mesh points. Assuming that the separation of variables of x and y coordinates is possible in a coarse mesh in a reactor, the two sets of one-dimensional difference equations are solved by the alternating direction iteration method. Sample calculations for ^{235}U-H_2O thermal reactors show that this method gives fairly good results with few coarse and fine meshes and the computation time can be considerably reduced compared with the usual finite difference method. 9 references. (auth)

14319 STABILITY OF NONLINEAR SPACE-DEPENDENT REACTOR KINETICS. Kastenberg, William E.; Chambre, Paul L. (Univ. of California, Berkeley). Nucl. Sci. Eng., 31: 67-79 (1968).

The spatial and temporal behavior of neutron distributions governed by the nonlinear diffusion equation approximation to neutron transport theory is considered. Stability criteria for the equilibrium states of various reactor feedback models are determined by the method of comparison functions. The comparison functions are used to construct simple solutions with error bounds to the equations considered. The two reactor models considered are the prompt feedback and the adiabatic model. The stability of the equilibrium state was found to be governed by the generalized buckling κ_B^2 and its relationship to μ_0^2, the lowest eigenvalue of the associated linear Helmholtz equation. Negative feedback is considered in both cases. Since the comparison functions

bound the true solution from above and below, one can determine absolute errors of the approximations involved when constructing solutions. In a similar fashion, a bound on the maximum value of the excursion can also be obtained with little extra effort. 23 references. (auth)

14320 USE OF DUAL VARIATIONAL PRINCIPLES FOR THE ESTIMATION OF ERROR IN APPROXIMATE SOLUTIONS OF DIFFUSION PROBLEMS. Yasinsky, J. B.; Kaplan, S. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng., 31: 80-90(1968).

A method for using reciprocal variational problems to develop figures of merit for approximate solutions of diffusion problems is presented. The theory of the reciprocal problems is described in both a continuous and discrete context. Connections with the method of Slobodyansky are discussed. A strategem is presented for extending the method to the (non-self-adjoint) group-diffusion case. Limitations of the method are discussed and numerical examples given. It is concluded that the method is useful in one-, two-, and perhaps in small three-dimensional problems but is probably computationally not practical for full-blown, detailed, three-dimensional calculations. 9 references. (auth)

14321 SOLVING CERTAIN GROUP-DIFFUSION PROBLEMS IN FINITE-DIFFERENCE FORM. Tobias, Melvin (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 31: 157-60(Jan. 1968).

Use of a finite differences method to obtain answers to diffusion theory problems is explained; these answers can then be used to check diffusion theory codes. The similarities between the finite differences method and differential equations solutions are shown. (M.L.S.)

14322 LOADING AND UNLOADING DEVICE FOR THE FUEL ELEMENT CONTAINED IN THE CHANNEL OF A NUCLEAR REACTOR. Gillieron, C.; Vitry, P. (to Indatom SARL). Canadian Patent 764,050. July 25, 1967. Priority date Jan. 19, 1962, France.

This refueling machine operates in a chamber formed by two protective screens placed above the reactor core. The chamber contains a cylindrical hole shut off by a swiveling plug. "A stocking and handling arrangement" with a suitable guiding means and movable on a trolley is fixed to the lower surface of the plug. Devices for gaining access to any fuel channel are described. (F.S.A.)

14323 CORE STRUCTURE FOR SOLID MODERATOR NUCLEAR REACTOR. Boutin, C.; Foglia, S.; Lemesle, G.; Martin, R.; Rouge, P. (to Commissariat a l'Energie Atomique). Canadian Patent 763,042. July 11, 1967. Priority date Mar. 27, 1962, France.

The moderator material is fabricated into bars or columns, having a cross section in the form of a polygon from four to eight sides. The columns have slots in three or more sides or corners forming a firm core with the aid of long keys placed parallel to the columns. Open spaces are left for the insertion of fuel rods. Some of the moderator columns have a central hole for insertion of control rods but the fuel is placed in the polygonal space when a column is omitted. The lattice pitch may be changed fairly easily in such an assembly. (F.S.A.)

14324 REACTOR CONTROL-ROD DRIVE. Nagahata, Yasuo (to Hitachi Shipbuilding and Engineering Co., Ltd.). Japanese Patent 1966-14416. July 5, 1966. Filed Jan. 30, 1959.

The reactor control-rod drive proposed consists of a protrusion at the bottom of the reactor pressure vessel; the protrusion itself is a combination of the one-end closed outermost cylindrical body and the two inner cylindrical bodies. The rod, connecting to a "control rod," is inserted from upward into the middle of the multicylindrical body. Traveling gears, located within the protrusion, and racks cut on either the inside or outside surface of the cylindrical bodies make possible the movement, either upward or downward, of the drive rod; the power of drive is supplied from an outside electric motor. The undesirable rotation of each cylindrical body with respect to each other is prevented by pieces of metal inserted between the cylindrical bodies. (NSA of Japan)

14325 METHOD FOR CONSTRUCTING A NUCLEAR FUEL ROD. Iizuka, Tomio (to Hitachi Ltd.). Japanese Patent 1966-14956. Aug. 23, 1966. Filed Apr. 1, 1963.

In pellet-type fuel rods the pellets are loosely contained to give room for thermal expansion. A spring is used to maintain compression. The insertion of a spring in rod construction is difficult when the spring is strong in tension. In the proposed method, an improvement in spring connection is presented, and yet the pellet arrangement is maintained. One end of a cladding tube is closed, and pellets are placed in it. A spring (to press a train of pellets) is compressed to a given length and held there by means of a wire of a material such as Pb–Bi or Pb–Sn, which has a small neutron absorption cross-section. This "compressed" spring is inserted in the cladding tube containing the pellets. The other, remaining end is closed with a plug and welded together. Finally, the assembled fuel-rod is heated externally to break the wire and make the spring operate. (NSA of Japan)

14326 BLANKET FOR SUPPORTING A REACTOR CORE. Ukaji, Hideo (to Hitachi Ltd.). Japanese Patent 1966-12957. June 18, 1966. Filed June 14, 1963.

An improved blanket is proposed for supporting a reactor core in the pressure vessel. A plurality of pipes are fixed to and around the inner surface of the pressure vessel at the position (or level) of the vessel length corresponding to the bottom of the reactor core. This pipe is made by bending a plate; but the pipe is open in the axial direction by bending the sides of a plate and not bringing them into contact. These pipes are fixed onto the vessel wall by the "open" side. A cut is made on the opposite side of each pipe to receive the edge of the grid plate, which supports the reactor core. (NSA of Japan)

14327 BRAKING DEVICE. (to Commissariat a l'Energie Atomique). French Patent 1,433,415. Feb. 21, 1966. Filed Feb. 8, 1965.

An object moving in a straight path is mechanically braked by a helical spring extending from a fixed support in a direction opposite to the direction of the moving object. The moving object has a cylindrical portion dimensioned to make force fit engagement with the spring and has a diameter greater than the internal diameter of the spring in its normal state. The turns of the spring are held against relative rotation by means of pins each engaged in a pair of opposed radially extending recesses provided in adjacent turns. Since the spring turns cannot rotate relative to one another, the turns bind on the cylindrical part of the object retarding its movement with a friction force which is precisely a function of the binding effect. (IIB)

14328 BEARING SYSTEM FOR THE SKIRT SUPPORTING A NUCLEAR REACTOR. (to Electricite de France (Service National)). French Patent 1,409,841. July 26, 1965. Filed Sept. 21, 1964.

The supporting structure for the core of an integral nuclear reactor comprises a cylindrical skirt supporting the core and surrounding the heat exchanger. The force is transmitted from the skirt to the lower portion of the reactor vessel by means of a plurality of angularly spaced identical pillar assemblies each including a resilient compression bar. Bearing means consisting of a rolling panel compensate the relative radial movement of the skirt and the compression bar. The compression bars exhibit a ratio between axial deformation and compressive force which is sufficient to maintain a substantially even distribution of the total load between all pillar assemblies. (IIB)

14329 LIFTING MECHANISM. (to Commissariat a l'Energie Atomique). French Patent 1,380,553. Oct. 26, 1964. Filed Oct. 1, 1963.

The mechanism is especially intended for use in a nuclear reactor facility for the purpose of lifting covers of tanks or leak-tight vessels, fitted with liquid seals. The cover is lifted to a height such that the seal is broken and then remains suspended above the seal for a certain period of time in order to allow it to drip and thus prevent the liquid of the seal from being dispersed within the vessel. The lifting mechanism is constructed in such a way that the upward travel of the cover is broken down into two stages; in the first stage the cover is lifted vertically while remaining parallel to the plane of the opening which it covers and in the second stage, the cover is removed so as to free the opening. (IIB)

14330 SPECIFICATION FOR CARBON AND LOW ALLOY STEEL CONTAINMENT STRUCTURES FOR STATIONARY NUCLEAR POWER REACTORS. British Standard 4208: 1967. London, British Standards Institution, 1967. 91p. 60s.

The design, construction, inspection and testing of structures for temperatures not exceeding 300°C are covered, such structures not being in contact with the reactor coolant during normal operation. Pressure-relieved structures are included, provided they are of a form that contains fission products or ensures their safe disposal. Attachments such as air locks or piping that are or may become directly connected between the interior of the containment structure and a closure, and may therefore contain radioactive material released during accidents, are considered part of the containment structure. (UK)

14331 METHOD FOR SHIM CONTROL OF A NUCLEAR REACTOR. Horibe, Osamu (to Kawasaki Dockyard Co., Ltd.). Japanese Patent 1967-1840. Jan. 27, 1967. Filed Mar. 10, 1964.

By the method proposed, the chemical shim-control injection and withdrawal of liquid poison can be done automatically by means of a signal derived from the change in position of a regulating rod; the measurement of the poison amount in the reactor is not required. Members of issuing a signal with respect to the displacement from the proper position of a regulating rod are installed. The relative positions of the members are such that in the injection or withdrawal of liquid poison the start is not as rapid as the stop. Thereby, the position of the regulating rod can always be corrected with respect to its proper position and the shim control done very effectively. (NSA of Japan)

14332 REACTOR CONTROL-ROD DRIVE. Masuda, Yasunao (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-12156. July 5, 1966. Filed Sept. 12, 1963.

In the reactor control-rod drive proposed, improvement is made in rapidly moving control rod to the reactor scram position. Using the control-rod drive proposed, the control rod can be driven slowly in and out of the reactor core in regulating the power output, and in the reactor scram it can be brought rapidly to its given position to shut down the reactor without giving a shock to the system. The reactor control-rod drive consists of the following: the main piston connected to the drive rod and control rod in order; the cylindrical body containing the (main) piston with the control-rod side end being an electromagnet (which attracts the piston when required) and the other end inserted with the auxiliary piston which is fixed onto the base through its (piston) rod; a device for driving the cylindrical body (and hence the control rod) in the axial direction; a device for supplying constantly a high-pressure fluid into the space between the electromagnet and the control rod. (NSA of Japan)

14333 METHOD FOR CONTROLLING A NUCLEAR REACTOR. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1966-12157. July 5, 1966. Filed Sept. 17, 1963.

The reactor-control method proposed is for regulating the reactivity as the fuel is burned. Surrounding the reactor are placed neutron reflectors, and inside and along each reflector runs a passage outward from the core. Through this passage a neutron-absorbing plate is moved as required for purposes of reactivity regulation. (NSA of Japan)

14334 METHOD FOR CONTROLLING A NUCLEAR REACTOR. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1966-12158. July 5, 1966. Filed Sept. 17, 1963.

In the reactor control method proposed, the reactivity, as the fuel burn-up proceeds, is regulated by changing the reflecting effect of a reflector surrounding the reactor core. In a nuclear reactor where a fluid reflector surrounds the reactor core, neutron-absorbing plates are placed within the reflector surrounding the reactor core. By moving the absorber plates the distance from the core to the plate, the thickness of the so-to-speak (fluid) reflector layer can be changed, thereby enabling the regulation of reactor reactivity. (NSA of Japan)

14335 STRUCTURE FOR SUPPORTING REACTOR CONTROL ELEMENTS. Nakamura, Shoichiro (to Hitachi Ltd.). Japanese Patent 1966-14879. July 11, 1966. Filed Aug. 13, 1963.

The control-element supporting structure proposed is used for a hollow reactor control-rod. The control elements are obtained by filling the powder of a neutron absorbing material into a tubular body. The supports for the control elements are fixed on the outside surface of the upper and lower ends of the inner wall (of a hollow-control rod). The control elements are arranged along the outside circumference of the inner wall, supported by the top and bottom supports. Then, the outer wall (or the outer casing) is placed, surrounding the whole arrangement (including control elements, the inner wall or inner casing). In this way of constructing a hollow control-rod, the fuel elements can be freely inserted or removed, as required. (NSA of Japan)

14336 EMERGENCY COOLING DEVICE FOR A REACTOR CONTAINER. Fujie, Hideo (to Hitachi Ltd.). Japanese Patent 1967-2955. Feb. 21, 1967. Filed May 24, 1963.

When the reactor pressure-vessel is ruptured, the high internal pressure in the containment vessel must be rapidly reduced to prevent the radioactive materials from leaking into the outside atmosphere. By the method proposed, this pressure can be lowered very effectively and also the floating radioactive-materials can be caught efficiently. Among the many sprays on to the inner surface of the containment vessel are installed cloth curtains. These curtains are put away in their respective containers in the normal condition of the nuclear reactor. When a rupture has occurred, they are jetted out to suspend from the top vessel wall. (NSA of Japan)

14337 FUEL TRANSPORT DEVICE. Ito, Yoshiharu (to Hitachi Ltd.). Japanese Patent 1966-12720. June 15, 1966. Filed Jan. 21, 1963.

The fuel transport device proposed is used for transporting spent fuel from the reactor core to the spent fuel storage tank, which is located between the two walls of a double-walled containment vessel. From the water tank in the pressure vessel (contained in the double-walled containment vessel), to the spent fuel storage tank (which is a part of the circular water tank between the two walls), runs a guide duct. Through this duct a fuel container is carried up or down by means of a rope; the container is fixed onto its carrier, rotatable but so as to be upright by the force of gravitation. While running through the guide, the carrier takes a lying posture, due to the particular cross-sectional space of the guide duct. But when it comes out of the duct, either in the water tank (above the core) or the fuel storage tank, it takes an upright posture. (NSA of Japan)

14338 DEVICE FOR PREVENTING A NUCLEAR-REACTOR HAZARD. Tagami, Takashi (to Hitachi Ltd.). Japanese Patent 1967-79. Jan. 6, 1967. Filed Dec. 15, 1964.

The device proposed is used for spraying water, and thus reducing the internal pressure, when a primary coolant pipe ruptures in the reactor containment vessel. The advantages of the method are the elimination of a power source for the spray, the direct and automatic spraying, and the positive instantaneous lowering of the internal pressure. The increase in internal pressure of the pressure vessel is transmitted through the conduit pipe to a piston in a cylinder (outside the vessel). Another piston is attached to the other end of the piston rod; this piston is within another cylinder. The latter cylinder is filled with water. When the piston rod moves by the force applied to the former piston, the water in the latter cylinder is pushed out. This water is led through a network of pipes installed within the pressure-vessel wall and ejected from nozzles located at appropriate points on the inner surface of the vessel wall. (NSA of Japan)

14339 METHOD FOR REACTOR START-UP. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1966-14558. Aug. 16, 1966. Filed June 12, 1963.

The reactor start-up is controlled by means of an electronic computer, which is both safe and rapid. It is particularly suitable for large power reactors with many control rods. Each cylindrical control-rod has a hollow section axially where the neutron flux is low when inserted in the reactor core; at the top end of this hollow space is installed a neutron detector, which gives a signal correspondent to the detected neutron flux. All the control rods are withdrawn at the same speed. Then, the neutron fluxes in the vicinity of each control rod are detected by the detector. With the definite condition that the control rod in the highest neutron-flux region is withdrawn over its whole length at the criticality, all other control rods are pulled outwards gradually for the reactor start-up. When each control-rod is drawn out, the detected information of neutron fluxes, both within and in the boundaries of the reactor core, are sent to an electronic computer, where the information as a whole is analyzed; then, the transient reactor output of reactor period after the other control rods have been withdrawn is also estimated. (NSA of Japan)

14340 NUCLEAR REACTOR FUEL ELEMENTS. Macfall, Derek; Butterfield, Colin Edgar; Butterfield, Roy Stuart (to United Kingdom Atomic Energy Authority). U. S. Patent 3,354,045. Nov. 26, 1965. Priority date Dec. 10, 1964, Great Britain.

A nuclear reactor fuel element is made up to a cluster of parallel fuel rods disposed within a sleeve of structural material. A support means for supporting the fuel rods at their lower ends comprises an annular member having an annular flange and an upper peripheral portion. The annular flange supports the sleeve, and a support grid for supporting the rods is secured to the upper peripheral portion. A central longitudinal member is mounted on the support means, and a lateral spacing member mounted on the central longitudinal member is disposed in the region of the upper ends of the fuel rods and is slidable relative to the sleeve. The fuel rods are slidable within the lateral spacing member. (TSS)

14341 NUCLEAR FUEL ELEMENT HAVING SHEATH OF ANTICLASTIC FORM. Craston, John Leslie; Pugh, Stanley Frederick (to United Kingdom Atomic Energy Authority). U. S. Patent 3,355,358. Apr. 11, 1966. Priority date Apr. 13, 1965, Great Britain.

A nuclear fuel element consists of a core of nuclear fuel enclosed within a gas tight sheath which comprises at least one pair of spaced parallel walls of anticlastic form. (TSS)

14342 FUEL ELEMENT FOR NUCLEAR REACTORS. Boettcher, Alfred (to Kernforschungsanlage des Landes

Nordthein-Westfalen e V). U. S. Patent 3,354,043. Jan. 3, 1966. Priority date Jan. 13, 1965, Germany.

A fuel element for a nuclear reactor consists of a carburizable metal shell composed of steel, Zr, or a Zr alloy and a mass of a fissionable element carbide within the shell. A metallic filler of a low-melting metal selected from the group consisting of Na, K, Hg, Bi, Pb, and amalgams and alloys of these metals is disposed between the mass of fissionable material and the shell. At least one metallic body of Zr-containing metal is imbedded in the filler for limiting carburization of the shell. (TSS)

14343 DEVICE FOR PREVENTING THE QUAKING OF A REACTOR CORE. Hamada, Kunio (to Hitachi Ltd.). Japanese Patent 1966-24480. Dec. 13, 1966. Filed Oct. 15, 1962.

By the proposed method, the vertical, as well as horizontal, quaking of a reactor core can be prevented. A blanket is fixed along the inner circumference of the pressure vessel; onto this are fixed two concentric rings along the same inner circumference, one on top of another, with the top one slightly protruding. On the side of the cylindrical support for the reactor core (it supports the latter on top of itself), a blanket is also fixed along its circumference; and along the outer edge of this circumferential blanket is fixed a concentric ring. Onto the lower side of this ring is fixed a "broad" circumferential ring, which engages, with its outer edge, with the cut made in the lower side of the pressure-vessel side blanket. The protrusion of the reactor-core side blanket, beyond the "first" ring, settles on the upper side of the other vessel-side blanket. (NSA of Japan)

14344 METHOD FOR CONSTRUCTING A REACTOR PRESSURE VESSEL. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1966-13319. July 26, 1966. Filed Oct. 25, 1963.

Using the method proposed, the assembly of a complicated reactor core in the pressure vessel can be facilitated, and also the constructed reactor pressure vessel itself can have an increased pressure resistance. The method is applicable for constructing a pressure vessel such as the one with its steel vessel (excepting the top) covered with ferro-concrete. The steel vessel (excluding the top) is first fabricated, divided in a plurality of vessel sections. As the assembly of a core proceeds, these vessel sections are gradually constructed into the form of a pressure vessel by mechanical joining each section. When the steel vessel is complete (leaving the part of a top), concrete is poured around the steel vessel. (NSA of Japan)

14345 DEVICE FOR REMOVING (AND INSERTING) A HORIZONTAL PLUG IN A NUCLEAR REACTOR. Wase, Keizo (to Hitachi Ltd.). Japanese Patent 1966-14399. July 4, 1966. Filed Feb. 8, 1963.

The proposed device for removing (and inserting) a horizontal plug has the following mechanism. A driving shaft, rotated by a motor, is installed in the back shield of the plug handler, and this shaft is connected to a chain pulley in the back of the handler. A lever is attached to the driving pulley on the end, and this lever also supports the axis of the chain pulley. The lever is suppressed by a suitable means, and a limit switch is installed opposite to the lever. When an abnormal force is applied to the horizontal plug, the (back) chain-pulley axis is pulled and then the lever turns around the driving shaft, thereby actuating the limit switch. When the abnormal force disappears, the lever is returned to its original position by the suppressing means, thus opening the limit switch. (NSA of Japan)

14346 NUCLEAR REACTOR GRID STRUCTURE. Ashcroft, David John; Timbs, Arthur Edwards (to United Kingdom Atomic Energy Authority). U. S. Patent 3,361,639. July 21, 1966. Priority date Aug. 10, 1965, Great Britain.

A description of a grid structure for a fuel element assembly is described. Methods for anchoring end-pins are given; formation of the grid recesses is described. (TSS)

14347 NUCLEAR REACTOR FUEL ASSEMBLY. Hassig, Jean Marc; Roche, Roland; Trelin, Jacques (to Commissariat a l'Energie Atomique). U. S. Patent 3,361,640. May 4, 1966. Priority date May 19, 1965, France.

A nuclear reactor fuel assembly is made up of pencils of canned fuel elements. Each fuel pencil has helical fins. The fins are notched to receive the secant fins of adjacent fuel pencils, axially interlocking the fins. (Offic. Gaz.)

14348 METHOD FOR CONSTRUCTING A NUCLEAR FUEL ELEMENT. Iizuka, Tomio (to Hitachi Ltd.). Japanese Patent 1966-16355. Sept. 14, 1966. Filed Jan. 17, 1963.

An improved method is proposed for constructing the type of fuel element in which parallel fuel-plates are held tight between the two support-plates. The advantages to the method, which is "mechanical," are the increased strength due to its cold working, and the elimination of neutron absorption by the remaining "flux" and the accompanying corrosion due to the usual soldering process. On both sides of a fuel plate, and on the upper and the lower surface, a groove is cut along the length of the plate. On one side of the (two) support plates are cut such (parallel) grooves as to receive the edge of the fuel plates; the latter snugs in the former groove. After assemblage of fuel plates and the support plates, a roller is run between the fuel plates to press the support plate, thereby fixing firmly fuel plates onto the support plates. (NSA of Japan)

14349 DEVICE FOR FIXING THE UPPER END OF A NUCLEAR FUEL ELEMENT. Nakai, Yasushi (to Mitsubishi Atomic Power Ind., Inc.). Japanese Patent 1966-16880. Aug. 4, 1966. Filed Nov. 4, 1963.

The upper part of a fuel element consists of the following: two opposing plates in the upper part of which is cut a hole; a pair of opposed levers, each in the shape of an arc, which are fixed on the inside of the two plates and rotatable at the middle pivot; and a mechanism, between the two levers, which moves the levers in rotation. The upper end of each lever has an outward protrusion, which moves through the hole of each plate. When the fuel element with the "upper part" is inserted in position through its guide tube, the upper end (of the fuel element) can be fixed, engaging with the lower end of the guide tube by means of the protrusions and other upper protrusions, and the inward protrusions of the guide tube. (NSA of Japan)

14350 HEAT-CONDUCTING FINS FOR A HEAT-TRANSFER TUBE. Okamoto, Yoshizo (to Japan Atomic Energy Research Inst.). Japanese Patent 1966-13076. July 22, 1966. Filed Apr. 23, 1962.

Improved heat-conducting fins are proposed for application in the vertical fins of a heat-transfer tube such as the tube containing a reactor fuel element. In the proposed heat-conducting fins of a heat-transfer tube, the following is done to the usual vertical fins in order to increase the heat conductivity. Vertical fins are fixed onto the outside of a tube, and helical (through the tube length) cuts are made in the vertical fins at regular intervals. The result is the separated fin parts of each vertical fin. The said cut is done in such a way that, in each separate part, its upper end is bent in one way and its lower end in the other way. (NSA of Japan)

14351 NUCLEAR REACTOR SYSTEM. Haneda, Mikio (to Nippon Atomic Ind. Group Co., Ltd.). Japanese Patent 1966-12560. July 16, 1966. Filed Oct. 15, 1963.

In the nuclear reactor system proposed, a peculiar safety system to be used to minimize a reactor run-away is provided. This safety device is made up of the following: a high-pressure water system to supply cooling water into the pressure vessel for a short period immediately after the run-away; and a low-pressure water system to supply cooling water into the vessel for a long period after the start of operation of this high-pressure system. (NSA of Japan)

14352 REACTOR CONTROL-ROD DRIVE. Masuda, Yasunao (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-12160. July 5, 1966. Filed Sept. 30, 1963.

Using the control-rod drive proposed, both the fine and rapid movements of a control rod can be done smoothly and definitely, and the rapid movement can be stopped at a specified position wherever the movement is started. The control-rod drive consists of the following: the main piston connected to the drive rod and the control rod in order; the cylinder containing the piston, with the control-rod end being an electromagnet (which attracts the piston when required) and with the other end being open; a device for driving the cylinder itself and hence the control rod in the axial direction; the auxiliary piston in the same cylinder positioned behind the main piston which is fixed onto the base through its (piston) rod; an air tank for supplying compressed air into the space between the electromagnet end (of the cylinder) and the main piston; and a device for driving the main piston to reduce or increase the volume between the electromagnet end (of the cylinder) and the main piston corresponding to the distance between the main and the auxiliary piston. (NSA of Japan)

14353 MULTI-PLATE TYPE FUEL ELEMENT. Nakai, Yasushi (to Mitsubishi Atomic Power Ind., Inc.). Japanese Patent 1966-16356. Sept. 14, 1966. Filed July 4, 1963.

In the proposed fuel element, the overall shape of the fuel element is a square tubular body with its two ends and sides support-plates. Axial plates, extending from one end to the other of the element, are fixed within the tubular body in a usual manner; but the fuel element, consisting of the tubular body and fuel plates, is twisted in the axial direction. (NSA of Japan)

14354 CLADDING METHOD FOR A NUCLEAR FUEL ELEMENT. Yamamoto, Tatsuro (to Furukawa Elec. Co., Ltd.). Japanese Patent 1966-14958. Aug. 23, 1966. Filed Feb. 1, 1963.

The proposed method, comprising two steps, has the advantages: prevention of the destruction of a cladding due to creep deformation, elimination of the growth of Magnox-alloy grains, and elimination of the need for a high pressure. In the first step, a uranium rod is inserted in the Magnox tube, and the assembly is pressed together at 100 to 300°C either in an inert-gas atmosphere or liquid. In the second step, the same is repeated but at 300 to 380°C to tightly attach the cladding on the surface of the fuel rod. (NSA of Japan)

14355 NUCLEAR REACTOR PRESSURE VESSEL AND METHOD OF CONSTRUCTING SAME. Beliaev, Karl Ivan Gunnar (to Aktiebolaget Atomenergi). U. S. Patent 3,356,588. Aug. 17, 1964. Priority date Aug. 22, 1963, Sweden.

The description of a dual-wall pressure vessel is presented. The pressure vessel consists of an inner vessel capable of containing the pressurized liquid coolant for the reactor core; an evacuate space between the inner and outer vessel; and an outer vessel capable of containing any excess pressure release. (TSS) (U.S. Pat. Gazette)

14356 METHOD FOR CONSTRUCTING A NUCLEAR FUEL ELEMENT. Yamamoto, Tatsuro (to Furukawa Elec. Co., Ltd.). Japanese Patent 1966-14957. Aug. 23, 1966. Filed Apr. 11, 1963.

By the proposed method, fuel elements enclosed tightly in their protecting cladding can be produced simply and in short periods of time; in addition, deformations at the ends of a fuel element are eliminated completely. After insertion of nuclear fuel in the form of a rod into its cladding tube, a plug of nearly the same diameter as the (fuel) rod is placed into one or both ends of the tube. The whole assembly is pressed together to give a fuel element, after which the deformed part at the end(s) of the tube is cut off. (NSA of Japan)

14357 NUCLEAR REACTOR. Dryland, Peter William; Pugh, Michael Charles (to United Kingdom Atomic Energy Authority). U. S. Patent 3,356,578. Apr. 4, 1966. Priority date Apr. 29, 1965, Great Britain.

The description of a reactor with multiple fuel assemblies in the core is presented. Each fuel assembly contains at least one control pin. Each fuel assembly also has a means for raising the assembly independently to the top support grid in the pressure vessel. (TSS) (U.S. Pat. Gazette)

14358 APPARATUS FOR DETERMINING THE INSTANTANEOUS OUTPUT OF A NUCLEAR REACTOR. Fishman, Ygal (to Sulzer Brothers, Ltd.). U. S. Patent 3,356,577. Sept. 16, 1964. Priority date Sept. 19, 1963, Switzerland.

A description of an electronic circuit for measuring the instantaneous output of a reactor is presented. The signal from a neutron flux detector is combined with the signal from a heat output detector and divided to produce a single output signal. Smoothing and multiplying devices are connected to the two detector signals. (TSS) (U.S. Pat. Gazette)

14359 FUEL SHEATHING FAILURE DETECTION IN LIQUID COOLED NUCLEAR REACTORS. McKnight, James Alan (to United Kingdom Atomic Energy Authority). U. S. Patent 3,356,576. Mar. 7, 1966. Priority date Mar. 8, 1965, Great Britain.

A testing method for cladding leakage in fuel elements of a liquid cooled reactor is described. The method consists of passing coolant over a fuel element and then passing the coolant through a tube with a rotary motion. Any bubbles in the coolant are forced centripetally to a position about the longitudinal axis and then restrained from axial movement by flow path obstructions. (TSS) (U.S. Pat. Gazette)

14360 FUEL ASSEMBLIES FOR A NEUTRONIC REACTOR. Heck, Francis M. Jr. (to Westinghouse Electric Corp.). U. S. Patent 3,356,587. June 21, 1963.

The description of a fuel assembly for a neutronic reactor is presented. The combination includes: an elongated casing structure; a plurality of elongated fuel bundles tandemly and sidably mounted within the casing; an elongated supporting member; and at least two of the fuel bundles being joined at opposite outwardly disposed end portions to a supporting member. The supporting member separates the fuel bundles upon temperature increase. (TSS) (U.S. Pat. Gazette)

14361 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Saunders, Alan Charles Anthony (to United Kingdom Atomic Energy Authority). U. S. Patent 3,356,582. Aug. 4, 1965. Priority date Aug. 11, 1964, Great Britain.

The description of a bracing grid for nuclear fuel rod clusters is presented. The bracing consists of a surrounding rim with symmetric resilient fingers to form grips for coolant tubes. The coolant tubes are arranged in parallel array. (TSS) (U.S. Pat. Gazette)

14362 NUCLEAR REACTOR INSTALLATION. Cairns, Walter John; Healy, John Barry (to United Kingdom Atomic Energy Authority). U. S. Patent 3,356,581. Sept. 30, 1965. Priority date Oct. 7, 1964, Great Britain.

The description of a nuclear reactor installation is presented. The reactor core includes: a calandria vessel; pressure tubes extending through the calandria tubes and terminating in standpipes; and radial projections and braces on the standpipes to hold the standpipes together. (TSS) (U.S. Pat. Gazette)

14363 NUCLEAR REACTOR CONTROL ROD WINDING ARRANGEMENTS. Long, Everett (to English Electric Co., Ltd.). U. S. Patent 3,361,635. May 5, 1965. Priority date May 7, 1964, Great Britain.

The description of a multiple control rod winding system is presented for a reactor with a pressure vessel and pile cap seal. The reactor contains a plurality of control-element channels with separate guide tubes fixed to each channel. The guide tubes converge to a single standpipe which penetrates the pile cap and provides access to a motor drive unit. Separate cables from each control-element channel pass through the guide tubes, up the standpipe, and connect to the motor drive for simultaneous movement. (TSS) (U.S. Pat. Gazette)

14364 NUCLEAR REACTOR WITH SOLID SUBSTANCE MODERATOR OF VARIABLE SLOWING-DOWN POWER. Bagge, Erich Rudolf (to Rolf Schlottau). U. S. Patent 3,361,636. Sept. 16, 1965. Priority date Sept. 17, 1964, Germany.

The description of a variable-moderated reactor is presented. The moderator consists of zirconium deuteride and zirconium hydride materials in varying geometries and densities. (TSS) (U.S. Pat. Gazette)

14365 METHOD AND APPARATUS FOR EXTRACTING AND USING THE HEAT OF A NUCLEAR REACTOR. Helbling, Willy (to Sulzer Brothers Ltd.). U. S. Patent 3,359,174. Apr. 5, 1965. Priority date Apr. 3, 1964, Switzerland.

The description of a heat transfer system for a reactor is presented. The system includes: a reactor; a pump, an evaporator, and a superheater each having a primary and secondary side; two turbines; and a conduit system. The flow system starts from the pump through the secondary side of the evaporator; the secondary side of the superheater; the first turbine; through the reactor; through the primary side of the superheater; through the reactor a second time; through the primary side of the evaporator; through the reactor a third time; and through the second turbine. (TSS) (U.S. Pat. Gazette)

14366 DEVICE FOR OPERATING NEUTRON-ABSORBING RODS IN NUCLEAR REACTORS. Olsson, Curt Sigvard (to Aktiebolaget Atomenergi). U. S. Patent 3,359,172. Oct. 8, 1965. Priority date Oct. 15, 1964, Sweden.

The description of a control rod assembly for a nuclear reactor is presented. The control rod is formed of a vertical neutron-absorbing material axially situated as a slide in a liquid pressure held position. The slide has recessed areas extending the full length of the slide to allow fluid passage when falling into the reactor core. The slide falls by its own weight and relatively freely. A lifting means is provided to elevate the slide into its upper position after falling into the core. (auth) (U. S. Pat. Gazette)

GENERAL

14367 (BNWL-592) INSTRUCTION DESIGN DESCRIPTION PREPARATION, PACIFIC NORTHWEST LABORATORY. Dulin, R. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1967. Contract AT(45-1)-1830. 25p. Dep. CFSTI.

Instructions for preparation of design descriptions for BNWL are given. They are prepared as guides for BNWL personnel and contractors, and are intended to supplement the DRDT Instructions for Preparation of System Design Descriptions. The Design Descriptions are presented in reference to FFTF design, as an example. (M.L.S.)

14368 (COO-1018-1111) AN INPUT-OUTPUT SYSTEM FOR A MULTIPROGRAMMED COMPUTER. Report No. 223. Cederquist, Gerald N. (Illinois Univ., Urbana. Dept. of Computer Science). Apr. 24, 1967. Contract AT(11-1)-1018. 88p. Dep. CFSTI.

Design specifications for a parallel input-output system for a multiprogrammed computer are presented. The system performs asynchronous time-division multiplexing of information transfers between a fast memory and a group of fast, synchronous input-output devices, allowing as many as eight input-output programs to execute simultaneously. (W.H K.)

14369 (COO-1018-1112) PROSPECTS AND PROBLEMS IN DESIGNING IMAGE ORIENTED INFORMATION SYSTEMS. Report No. 224. Ray, S. R. (Illinois Univ., Urbana. Dept. of Computer Science). May 8, 1967. Contract AT(11-1)-1018. 29p. (CONF-670643-2). Dep. CFSTI.

From Conference on Mechanized Information Storage, Retrieval, and Dissemination, Rome, Italy.

An experimental information retrieval system is described which includes high-speed dissemination. Data introduction and storage costs are reduced by the use of image format but the economic advantage of image format can be fully realized only if two concomitant problems are solved. First, the resolution of stored images must be tailored to fit the dissemination (video) channel capacity and reproduction equipment resolution, and secondly, a technique for locating and reducing text objects to Hollerith ("bit") format for the index is required. An integrated system design and associated techniques which provide a solution to these problems is presented. (auth)

14370 (COO-1018-1114) A CONTENT ADDRESSABLE MEMORY WITH APPLICATIONS TO MACHINE TRANSLATION. Report No. 227. Hayes, John P. (Illinois Univ., Urbana. Dept. of Computer Science). June 1, 1967. Contract AT(11-1)-1018. 71p. Dep. CFSTI.

Thesis.

Some aspects of the design of a processor based on a content-addressable memory and its application to the particular problem of machine translation were treated. (B.G.D.)

14371 (COO-1018-1115) THE THEORY AND IMPLEMENTATION OF SRT DIVISION. Report No. 230. Atkins III, Daniel E. (Illinois Univ., Urbana. Dept. of Computer Science). June 1, 1967. Contract AT(11-1)-1018. 72p. Dep. CFSTI.

Thesis.

A class of digital division techniques, called SRT division, especially suited for implementation in an electronic digital computer is described. The theory and properties of SRT division are presented, and an example of its use is illustrated. (W.H.K.)

14372 (COO-1018-1118) THE WEB SYSTEM. PART II. A FORMAL DESCRIPTION OF THE WEB INPUT LANGUAGE. Report No. 232. Bond, W. D.; Davidson, E. S.; McCormick, B. H. (Illinois Univ., Urbana. Dept. of Computer Science). June 19, 1967. Contract AT(11-1)-1018. 22p. Dep. CFSTI.

The input language for the WEB design automation system is described. The WEB input consists of a logic description, housing description, module description, and an assignment description. The syntax of the WEB language is included. (B.G.D.)

14373 (COO-1018-1121) TRANSLATOR GENERATOR SYSTEM. Report No. 237. McInnes, A. W. (Illinois Univ., Urbana. Dept. of Computer Science). July 12, 1967. Contract AT(11-1)-1018. 71p. Dep. CFSTI.

A system designed to produce a scanner from the Backus Naur Form definition of the syntax of a programming language is described. The main purpose of this system is to produce a purposive parsing system. (W.H.K.)

14374 (COO-1469-0068) A GRAPHICS DISPLAY LANGUAGE. Report No. 240. Henderson, Dugald Austin Jr. (Illinois Univ., Urbana. Dept. of Computer Science). Aug. 21, 1967. Contract AT(11-1)-1469. 136p. Dep. CFSTI.

Thesis.

A tentative language giving the ability to describe and produce planar figures composed of straight line segments and circle arcs is described. Two computer programs, both called HANDLER, which utilize this language are given. (W.H.K.)

14375 (CU-2663-38) PHYSICAL AND CHEMICAL OCEANOGRAPHIC OBSERVATIONS IN THE SOUTHERN OCEANS. USS ELTANIN Cruises 22-27, 1966-1967. Jacobs, Stanley S.; Amos, Anthony F. (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory). Nov. 1967. Contract AT(30-1)-2663. 291p. Dep. CFSTI.

Six cruises were made by the USNS EL TANIN between January 1966 and February 1967 through the Southern Oceans to obtain oceanographic information. Methods of data collection and processing are described. The results of continuously recorded in-situ salinity, temperature, depth measurements, hydrographic data, and chemical observations are presented in graphical and tabular form. (L.C.L.)

14376 (EGG-1183-288) TIMING CLOCK TYPE TD-92. Technical Manual Number B-3267. Planchet, Richard (EG and G, Inc., Boston, Mass. Eastern Science and Technology Div.). June 9, 1967. Contract AT(29-1)-1183. 50p. Dep. CFSTI.

An instruction manual is presented for the EG&G Timing Clock Type TD-92. Topics included are general information, installation operation, principles of operation, and maintenance. (B.G.D.)

14377 (K-1736) USER'S MANUAL: UCARDS. UNION CARBIDE AUTOMATIC ROUTING AND DESIGN SYSTEM FOR PRINTED CIRCUIT BOARDS. Jamison, J. F. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 25, 1968. Contract W-7405-eng-26. 91p. Dep. CFSTI.

UCARDS is a computer aided design system for producing component layout, conductor layout, and other aids to the fabrication of printed circuit boards. This manual is intended to serve as a guide to the proper use of the system. (auth)

14378 (LA-3797) MULTIPLE-IMAGE OBJECTIVE SYSTEM FOR A ROTATING-MIRROR CAMERA. Gardner, S. D. (Los Alamos Scientific Lab., N. Mex.). Aug. 10, 1967. Contract W-7405-eng-36. 8p. Dep. CFSTI.

An optical system is described which produces multiple images of an object on a rotating-mirror camera focal plane. The apparatus is made up of multiple optical trains, each train consisting of a pair of Dove prisms and collimating lenses which serve to form an image with arbitrary position and orientation at the camera focal plane. The instrument was designed to record the progress of a nonplanar shock wave or detonation wave along several nonparallel paths. When used with suitable object illumination it also permits framing pictures to be made of a dynamic event. (auth)

14379 (LA-DC-9167) VISUAL HULL OF A POLYHEDRON. Beyer, W. A. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 9p. (CONF-670833-1). Dep. CFSTI.

From Conference on Projections and Related Topics, Clemson, S. C.

The visual hull of a set in Euclidean 3-space is the largest set having the same orthogonal projections on all planes as the given set. It is shown how to construct a bounded polyhedron whose visual hull is not a polyhedron. (auth)

14380 (MLM-1446) DEVICE FOR DETERMINATION OF PRESSURE IN SEALED CONTAINERS. Furtsch, T. A.; Kershner, C. J. (Mound Lab., Miamisburg, Ohio). Oct. 30, 1967. Contract AT(33-1)-Gen-53. 10p. Dep. CFSTI.

A device was developed which permits determination of the effective gas pressure inside a closed container such as a sealed capsule. In this device, the container is punctured and the gas is allowed to flow into a closed system containing calibrated volumes and pressure gages. The original pressure in the container being evaluated is determined by means of calculations based on the pressure-volume data obtained from the measuring device. (auth)

14381 (NAA-SR-Memo-11915) AICRT3-3, SPRNTV, FLINTV: GENERAL PURPOSE SUBROUTINES FOR DISPLAY OF DIGITAL DATA (NAA PROGRAM DESCRIPTION). Boling, M. A.; Rhoades, W. A. (Atomics International, Canoga Park, Calif.). Apr. 1966. 43p. Dep. CFSTI.

AICRT3-3 is a general purpose FORTRAN IV subroutine for the display of output data in a graphical form. Its purpose is to provide a simple means for obtaining graphs as direct computer output. Generally satisfactory graphs of data supplied by the user are made, while little or no familiarity on the part of the user with the CRT library routines themselves is required. A special entry, CRTRPT, is provided to facilitate the making of repetitive plots. SPRNTV is a FORTRAN IV subroutine which prints a floating point number and its label on an SC-4020 graph. FLINTV is a FORTRAN IV subroutine which prints a fixed point number and its label on a SC-4020 graph. A special program, CRTCHK, to illustrate the use of these subroutines is included with the listings. (auth)

14382 (NP-17231) NINTH REPORT ON THE ACTIVITIES OF THE AGENCY. (Organization for Economic Co-Operation and Development, Paris (France). European Nuclear Energy Agency, Paris (France)). Dec. 1967. 72p. Dep.

The main events of 1967 were: start of operation with the second fuel charge in the Dragon reactor; completion of the Halden reactor's experimental programme with the second fuel charge; successful reprocessing of the first 30 tons of irradiated fuel at Eurochemic; and adoption after successful three-year trial periods of the Computer Programme Library at Ispra and the Neutron Data Compilation Centre at Saclay. An experimental international waste disposal operation in the Atlantic Ocean was also successfully carried out. (auth)

14383 (NVO-280-1) LONG PERIOD WAVE GAGE DEVELOPMENT. Final Report, Phase I Feasibility Study. (Ocean Science and Engineering Inc., Washington, D. C.). Jan. 18, 1967. Contract AT(26-1)-280. 64p. Dep. CFSTI.

A design study of instrumentation and techniques for measuring tsunami waves in the ocean is presented. Topics discussed include the dynamic analysis of buoys in a seaway by analog simulation, environmental parameters, equations of motion of the buoys and cable, and accelerometer measurements. (W.H.K.)

14384 (NVO-280-2) LONG PERIOD WAVE GAGE DEVELOPMENT. Final Report, Phase II Engineering Design, Phase III Prototype Construction. (Ocean Science and Engineering Inc., Washington, D. C.). Jan. 27, 1967. Contract AT-(26-1)-280. 21p. Dep. CFSTI.

The design and construction of the prototype long period wave gage are described. Also, the deployment procedure for the system is presented. (W.H.K.)

14385 (NVO-280-3) LONG PERIOD WAVE GAGE DEVELOPMENT. Final Report, Phase IV Prototype Test and Evaluation. (Ocean Science and Engineering Inc., Washington, D. C.). Aug. 28, 1967. Contract AT(26-1)-280. 35p. Dep. CFSTI.

The scientists' log kept by OSE during actual testing of the prototype long period wave gage is presented. Also, recommendations and comments on the buoy system and the launch and retrieval procedure are reported. (W.H.K.)

14386 (NYO-906-80) KINETICS AND STRUCTURAL STUDIES OF CHELATES β-DIKETONES WITH TRANSITION AND RARE EARTH METALS. Progress Report. Cefola, Michael (Fordham Univ., New York. Dept. of Chemistry). Jan. 1, 1968. Contract AT(30-1)-906. 19p. Dep. CFSTI.

In line with recent structural studies of the unusual eight coordination number of rare earth metals with β-diketones (4:1 ligand-to-metal ratio) in the form of ammonium salts, six coordinate zincate and cadmiate ammonium salts (3:1 ligand-to-metal ratio) were synthesized and complete x-ray structures will be determined. The ligand employed in the latter preparations was furoyltrifluoroacetone (FTA). Utilizing the Moessbauer effect, studies are currently in progress on the structures of acetylacetone and other β-diketone chelates of tin. Moessbauer measurements were made on many chelates of this type as well as the sulfur analog of β-diketones and tin. Data are being gathered on the relation of the Moessbauer chemical shift parameter and the ^{119}Sn-H coupling constants in the chelates. (auth)

14387 (ORNL-TM-2096) DECIDE: A COMPUTER SOLUTION OF PROBABILISTIC NETWORKS TO AID DECISION MAKING INVOLVING UNCERTAINTY. Snyder, F. T.; Stoddart, W. C.; Scott, P. E. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 46p. Dep. CFSTI.

Decision Evaluation Control Involving Doubtful Elements (DECIDE) is a computer program developed to analyze a network containing activities that occur probabilistically as well as those that occur with certainty and to predict outcomes in terms of probable occurrence, time, and cost. This systematic method of evaluating risk and uncertainty in research and development projects is intended to aid decision makers in evaluating the effects of uncertainties in determining the level of risk involved in a new project. A network plan is prepared to show the sequence of activities and the alternative courses and/or time and cost that are available or that may be required at decision points. A probability of occurrence value is assigned to each alternative action and the network is solved for probable values of terminal points. With these values, the merit of a proposed project can be determined, and this determination will recognize the possible effects of interrelated variables upon the success of the project. The DECIDE program can be applied to many areas such as the planning of projects and experiments, evaluation of projects and costs, and the analysis of processes. (auth)

14388 (ORO-2840-5) DIELECTRIC RELAXATION IN THE MIXTURES: BENZONITRILE + PROPIONITRILE, BENZONITRILE + ACETONITRILE AND IN ANILINE AND ANISOLE. Bhattacharyya, T. J.; Gopalan, T. V.; Kadaba, P. K. (Kentucky Univ., Lexington. Dept. of Electrical Engineering). Dec. 13, 1967. Contract AT(40-1)-2840. 9p. (CONF-670957-1). Dep. CFSTI.

From Conference on Electrical Insulation and Dielectric Phenomena, Pocono Manor, Pa.

Dielectric relaxation of mixtures of polar molecules has not been studied extensively in contrast with solutions of polar molecules in nonpolar solvents and pure polar liquids. The initial studies on dipolar mixtures involved relatively complex nonrigid molecules, the interpretation of the behavior of which as mixtures in any detail is vitiated by the complexity. Schallamach in his study of the temperature dependence at low temperatures of the order of -100°C and at a single radio frequency on mixtures of complex molecules, has come to the conclusion that the dielectric relaxation in mixtures involves the disturbance of relatively large regions in the liquids so much so the individuality of the two members is not significant. Studies on a single mixture of alkyl halides at temperatures close to the melting points of the individual components by Denney in the audio and radio-frequency regions seem to support Schallamach's conclusion. The investigation on mixtures of certain nitriles is a continuation of a study on mixtures of simple rigid polar molecules at microwave frequencies near room temperature. (auth)

14389 (ORO-2907-28) STUDIES IN THE PHYSICAL CHEMISTRY OF THE SELECTED HIGH-TEMPERATURE SYSTEMS. Progress Report, December 1, 1966-November 30, 1967. Margrave, John L.; Pitzer, Kenneth S. (Rice Univ., Houston, Tex. Dept. of Chemistry). Dec. 1967. Contract AT(40-1)-2907. 8p. Dep. CFSTI.

Mass-spectrometric examinations of fluorine-containing systems were carried out to provide vapor pressure data and bond energies for high-temperature species. Fluorine combustion studies are being carried out on a variety of materials. The matrix isolation apparatus was modified for use at liquid helium temperature. Optical and ESR spectroscopy of fluorides is also discussed. High-temperature research, molecular-beam research, and theoretical studies are discussed. (M.C.G.)

14390 (RISO-152) ASYNCHRONOUS SHIFT REGISTER FOR SERIAL TO PARALLEL CONVERSION WITH PROGRAMMED CONTROL. Hansen, K. B. (Danish Atomic Energy Commission, Risoe. Research Establishment). Aug. 1967. 15p. Dep.

The serial to parallel conversion register described is used in common bus-constructed digital systems together with other functional units. The register is called by a special 7-bit coded symbol, an address character and the following coded numerals are led to the shift register and collected into a number, to be used e.g., as a reference number or set point in a digital positioning system. The use of asynchronous control guarantees the correct transfer of information to and from the register independently of the reaction times of the units with which it cooperates. (Denmark)

14391 (RLO-1929-6) RADIOTELEMETRY OF LARGE WESTERN MAMMALS. Progress Report, 1965-1966. Craighead, John J.; Craighead, Frank C. Jr. (Montana Cooperative Wildlife Research Univ., Missoula). Contract AT(45-1)-1929. 67p. Dep. CFSTI.

Radiotracking and radiotelemetry equipment was developed for large game animals in the Yellowstone National Park—Jackson Hole area. Data are presented on the testing of the equipment under operational conditions. Behavioral and ecological information was obtained from free-roaming elks and bears. Daily movements, seasonal ranges, activity patterns, seasonal activity rhythms, food habits, and individual and group behavior were observed. Radiotelemetry instruments were designed to provide continuous recording of body temperatures and EKG patterns of elks and bears. Physiological data were then correlated with behavioral and ecological data obtained from the radio-tracking

system. Advanced techniques facilitate information gathering that is no longer the limiting factor in the study. Of primary concern now is the correlation of the data obtained from the various systems into a pattern suitable for expression of the ecological activities of these mammals. (E.R.B.)

14392 (SC-CR-67-2533) A TECHNIQUE FOR STUDYING INTERACTIONS BETWEEN A SUPERSONIC BODY AND BLAST WAVES APPROACHING OBLIQUELY. Damkevala, Rusi Jal; Zumwalt, Glen W. (Oklahoma State Univ., Stillwater). May 1967. Contract AT(29-1)-789. 122p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

A technique was developed for studying the oblique shock-on-shock interactions between a rifle-launched model and a cylindrical shock wave from a shock tube. The interaction angle could vary from 0° and 90° (head-on), depending upon the distance from the end of the shock tube to the point at which the interaction was made to take place. In the present work, oblique interactions were studied and a sufficient number of photographs were obtained so that whole sequences of events at three selected shock strengths and model Mach numbers could be studied. Both air and Freon-114 were used as the medium in the interaction chamber. The model used for all the tests was a 19.5° cone-cylinder, the cylinder being 0.375" in diameter. (auth)

14393 (SC-CR-67-2751) DEVELOPMENT AND ANALYSIS OF TECHNIQUES FOR CALIBRATION OF KERR CELL PULSE-VOLTAGE MEASURING SYSTEMS. Cassidy, Esther C.; Cones, H. N. (National Bureau of Standards, Washington, D. C.). Sept. 1967. Contracts AT(29-1)-789; ASB28-8222. 46p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

Two methods of calibration were developed and evaluated for a Kerr cell pulse voltage measuring system. An attempt was made to achieve calibration without reference to conventional pulse divider techniques. Pulse measurements using a Kerr cell (interplate distance = 0.25 cm) calibrated by these methods showed that the Kerr cell results were accurate at least to the same degree as calibrated divider results, the difference between the two being less than 1%. However, results obtained with a cell of greater interplate spacing (0.75 cm) differed considerably (by up to 6%) from simultaneous divider results. A nonuniform field distribution between the plates was found to be the principal source of error, and a technique of correcting for the complications added by the nonuniform field was devised. Measurements after correction agreed with the calibrated divider results to within 1.5%. (B.G.D.)

14394 (SC-RR-67-123) A CLOSED FORM APPROXIMATE SOLUTION FOR THE INITIAL REENTRY ANGLE AND VELOCITY OF OBJECTS DECAYING FROM CIRCULAR ORBITS AROUND AN OBLATE ROTATING PLANET (EVALUATED FOR EARTH FOR SIX ATMOSPHERIC MODELS). Spahr, H. R. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1967. 240p. Dep. CFSTI.

A closed form approximate solution was developed and used to calculate the initial reentry angle and velocity for objects decaying from earth orbits. This solution includes the planet's rotation, its oblateness, and the second harmonic in its gravitational field. The variables for which the reentry angles and velocity are calculated include altitude, orbital inclination, latitude, and atmospheric models. The ballistic coefficient dependence is eliminated by presenting the product of ballistic coefficient and drag reentry angle. The closed form approximate solution is compared, for several cases, with "exact" solutions obtained by the numerical integration of the differential equations of motion. These comparisons define the region of validity for the approximate closed form solution. (auth)

14395 (SC-PR-67-656-A) ROLAMITE: A NEW MECHANICAL DESIGN CONCEPT. Wilkes, D. F. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. Contract AT(29-1)-789. 215p. Dep. CFSTI.

Supersedes SC-RR-67-656.

The recently developed rolamite geometry forms an extremely tolerant precision rolling suspension suitable for a wide range of applications and does not require precision tolerance machining to manufacture. Rolamite exhibits coefficients of friction 1 to 10 percent of the values obtained from conventional bearings; no lubrication is required. Rolamite geometry produces axial forces of any desired character. It can provide nearly all the mechanical functions normally discussed in mechanical engineering machine design text books as well as many electromechanical functions. The simplicity of the rolamite geometry enables the design of innumerable complete electromechanical devices composed of only 4 to 10 piece-parts. A modular design suitable for producing a wide range of microminiature weapon components in which one key part provides from 80 to 95 percent of the necessary functions is being developed. These parts, to be designed by a computerized process, will be produced by strip-processing by means of high-rate photochemical methods and photo masters which could easily be adapted for mass production. These masters are traced out automatically from machine tool instructions produced during the original computer design process. (auth)

14396 (SC-TM-67-2977) COMPUTER PROGRAMS FOR DYNAMIC RESPONSE OF PARTIALLY NONLINEAR SYSTEMS. Murfin, Walter B. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1968. Contract AT(29-1)-789. 29p. Dep. CFSTI.

The use of a series of computer programs is described. (auth)

14397 (SCL-DR-65-102) FILAMENT WINDING A SURFACE OF REVOLUTION. Gold, S. P. (Sandia Corp., Livermore, Calif.). Feb. 1966. Contract AT(29-1)-789. 38p. Dep. CFSTI.

Various lemmas and proofs that are useful for filament winding a surface of revolution are presented. It is proved that the family of geodesics on an approximating surface converges to the family of geodesics on the actual surface. In addition, the amount that a filament path can deviate from a geodesic and not slip from the surface is calculated. (auth)

14398 (TID-3744) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Issued or in Progress During the Period, November–December 1967. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 8p. Dep. DTIE Free.

References are presented for sixty-five bibliographies on atomic energy literature, published or in preparation during the period November to December 1967. A report number index is included. (B.G.D.)

14399 (TID-4579) SERIAL TITLES CITED IN NUCLEAR SCIENCE ABSTRACTS. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Jan. 1968. 240p. CFSTI.

The serial titles which represent the journals from which articles are abstracted in Nuclear Science Abstracts are presented. These include both those serials scanned and those selected for citation from other abstract journals, from bibliographies, and from reprints received from authors. (B.G.D.)

14400 (UCID-15258) MATERIAL SPECIFICATION FOR LX-04-1 MOLDING POWDER. Scribner, K. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 8, 1963. Contract W-7405-eng-48. 10p. Dep. CFSTI.

Material specifications for LX-04-01 molding powder, a type of high explosive mixture, are given. The powder is a mixture of HMX particles uniformly coated with Viton fluoroelastomer. (F.S.)

14401 (UCRL-13332) MASS SPECTROMETRIC ANALYSIS OF THE PYROLYSIS PRODUCTS OF POLYMERIC MATERIALS. Final Report, July 18, 1966–July 17, 1967. Goldstein, Harold W. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Dec. 1967. Contract W-7405-eng-48. 92p. Dep. CFSTI.

For Univ. of California, Livermore.

A program was undertaken to quantitatively determine the gaseous products from the heating in vacuum of selected polymeric materials. The materials investigated during this phase of the program were Skybond 700, poly-2, 2'(m-phenylene)-5,5'-bibenzimidazole, Dow Corning Q93-029, and Union Carbide Y-3602. Small amounts of the material were polymerized in notches machined in graphite filaments and heated rapidly (several seconds) to constant temperature (in the range 400 to 1000°C) in a vacuum chamber connected to a time-of-flight mass spectrometer. The pyrolysis gases were identified mass spectrometrically during the time it took the sample to reach constant temperature and while it was maintained at constant temperature. The mass spectrometer circuitry was modified to permit scanning the mass range 1 to approximately 400 every 0.2 second. The weight of sample pyrolyzed was obtained by measurement of the weight of polymer before and after heating. The gaseous products identified from Skybond 700 are benzonitrile, toluene, aniline, benzene, carbon dioxide, ethane, nitrogen and carbon monoxide and ethylene, hydrogen cyanide, acetylene, water, ammonia, methane, and hydrogen. The products identified from poly-2, 2'(m-phenylene)-5,5'-bibenzimidazole are phthalonitrile, benzimidazole, benzonitrile, aniline, benzene, carbon dioxide, nitrogen and carbon monoxide, hydrogen cyanide, water, ammonia, methane, and hydrogen. The products identified from Dow Corning Q93-029 are octamethylcyclotetrasiloxane, a product having a principal peak at m/e-207, water, and hydrogen; in the case of Union Carbide Y-3602 the products identified are octamethylcyclotetrasiloxane, products having principal peaks at m/e-340 and 207, carbon dioxide, and water. (auth)

14402 (UCRL-13334) STRENGTH PROPERTIES OF ROCK IN TRIAXIAL COMPRESSION. Smith, James L.; DeVries, K. Lawrence; Bushnell, Dwight J.; Brown, Wayne S. (Utah Univ., Salt Lake City. Dept. of Mechanical Engineering). Sept. 1967. Contract P. O. 5921803. 50p. Dep. CFSTI.

For Univ. of California, Livermore.

Test results are reported from triaxial compression experiments on sandstone, granite, marble, and shale specimens with the hydrostatic confining pressure varying from atmospheric pressure to a maximum of 90,000 psi corresponding to a mean stress of 143,000 psi. Stress measurements were made with a load cell incorporated into the loading piston and axial strain was measured inside the pressure vessel with a linear variable differential transformer developed for the experiments. Results are presented in the form of stress-strain curves for individual specimens and maximum shear stress vs mean stress curves for each material. A number of tests made with granite specimens which had been previously fractured showed that if the confining pressure was above 30,000 psi the precracked specimens exhibited behavior similar to intact granite. (auth)

14403 (UCRL-17934) ERROR CHECKING AND OTHER ASPECTS OF DATA-LINK ORGANIZATION. Lafore, Robert W. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 8, 1967. Contract W-7405-eng-48. 6p. (CONF-671123-2). Dep. CFSTI.

From Fall Digital Equipment Computer Users' Society Symposium, Anaheim, Calif.

The arrangement of registers in the data link permits error detection and correction and solves the problem of synchronizing the computers at the ends of the line. Preliminary information must be exchanged between the two synchronizers before a data record may be sent. The approach to the logic design of the system is also briefly described. (auth)

14404 (UR-49-798) MUTATION AND RECOMBINATION STUDIES OF GENES CONTROLLING YEAST CYTOCHROME c. Parker, John Hamilton (Rochester Univ., N. Y.). 1967. Contract W-7401-eng-49. 122p. Dep. CFSTI.

Thesis.

Yeast (Saccharomyces cerevisiae) is a eukaryotic organism, demonstrating a typical Mendelian-type inheritance. Results are reported from an investigation of a series of genes that control the concentration of cytochrome c in yeast. Fine-structure maps of three of these genes (cy_1, cy_2 and cy_3) were constructed. (C.H.)

14405 (Y-1580) INSTRUMENTATION FOR DYNAMIC MEASUREMENTS OF RESISTANCE WELDING CURRENT AND ELECTRODE FORCE. Bowden, B. B.; Hoskins, J. A.; Quinnell, R. D.; Scott, D. G.; Turner, P. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Jan. 23, 1968. Contract W-7405-eng-26. 23p. Dep. CFSTI.

Instrumentation has been designed that can dynamically determine the current and electrode-force changes during a resistance welding cycle. Since the information obtained can be recorded and studied, resistance welds can be more accurately reproduced. (auth)

14406 (Y-DA-1999) PHOTOGRAPHIC METHOD OF INVESTIGATING CHIP FLOW IN TWO-FLUTE TWIST DRILLS. Williams, R. L.; Trigger, K. J. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). [1966]. Contract W-7405-eng-26. 9p. (CONF-680104-1). Dep. CFSTI.

From ASTME Material Removal Seminar, Hartford, Conn.

An investigation of two-flute drill chip flow using a photographic method is described in which a 20 × microscope was used as the observation point. The microscope was coupled to photographic equipment. The formation of the chip in the region of the chisel edge was observed. Acrylic plastic was chosen as the material being drilled. A computer program was used to compute the helix angle, inclination angle, face rake angle, effective rake angle, and the normal rake angle along the cutting edge. It was found that a drill accurately ground on the face to increase the axial rake close to the chisel edge will produce better chip flow. (F.S.)

14407 (BNL-tr-183) REACTIONS BETWEEN CYANOCOBALT(II) COMPLEX AND α-AMINO ACIDS. Suzuki, Tetsumi; Kwan, Takao. Translated for Brookhaven National Lab., Upton, N. Y., from Nippon Kagaku Zasshi, 88: 395-400(1967). 17p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Reactions between cyanocobalt(II) complexes and some α-amino acids were investigated in an aqueous solution. They reacted with each other in a stoichiometric ratio $[Co(CN)_5]^{3-}$: α-amino acid = 1 : 1. Some complexes were isolated and identified by chemical analysis and infrared spectroscopy to be $K_2[Co(CN)_4NH_2RCOO] \cdot nH_2O$(R = alkyl groups). The complex $[Co(CN)_4NH_2CH_2COOH]^{2-}$ obtained by the interaction of cyanocobalt(II) complex with glycine reacted quickly with butadiene giving butenes without producing butane, and reacted with allylbromide giving propylene. The source of hydrogen in the hydrogenation of butadiene was a hydrogen atom of the carboxyl group of glycine. The dissociation of the hydrogen-oxygen bond would probably be effected by the electron transfer from cobalt(II) to the carboxyl group of glycine. (auth)

14408 (LA-tr-68-2) EXPERIMENTAL AND THEORETICAL STUDY OF THE GENERATION OF DETONATION BY SHOCK WAVE IN A GRANULAR EXPLOSIVE. Bernier, H.; Lezaud, J. M.; Chevalier, Y. Translated for Los Alamos Scientific Lab., N. Mex., from Paper Presented at International Symposium on the Behavior of Dense Media Under High Impulsive Pressures, Paris, France. 10p. (CONF-670914-13). Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

A description is given of experimental results obtained in generating the detonation by shock wave in a hexolite and stress on the testing precautions taken. According to the intensity of the pressure signal, considerable differences are noted when the detonation is produced. A qualitative interpretation of all the results is proposed. They are confirmed for a certain number of points by a mathematical model run through the computer. (auth)

14409 (UCRL-Trans-1361) ZERO STABILITY OF DIRECTLY COUPLED D.C. AMPLIFIERS. Drescher, K. Translated by A. B. Herrmann for Univ. of California, Lawrence Radiation Lab., Berkeley, from Nachrichtentechnik, 16: 350-4(1966). 21p. Dep. CFSTI. JCL $2.60 fs, $0.83 mf.

An attempt to trace the zero fluctuations of the dc amplifier to the interference factors in order to evaluate the operational conditions and possibilities of use of the dc amplifier and to determine the optimal dimensional conditions is described. Interference factors considered are fluctuations of the heater voltage, fluctuations of operational anode voltages, and alterations of the properties of the structural elements through aging and temperature effects. (W.H.K.)

14410 (UCRL-Trans-10138) FORMATION OF AN EXCAVATION BY A 1009 t THROW-OUT BLAST. Dashkov, A. N. Translated by J. Bradley for Univ. of California, Lawrence Radiation Lab., Livermore, from Transp. Stroit., 10: No. 11, 10-12(1960). 11p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

A 1009 ton throw-out blast was used to excavate an earth cut for a railway. The planning and blasting technique are described. The results are evaluated in terms of cost, safety, and how closely the desired excavation contour and volume were achieved. This large scale throw-out blast demonstrated the high efficiency of producing excavations by blasting. (L.C.L.)

14411 (UCRL-Trans-10154) ICE CONDITIONS IN THE DAVIS SEA, JANUARY-APRIL 1963. Kozlovskii, A. M. Translated by Robert Addis for Univ. of California, Lawrence Radiation Lab., Livermore, from Inform. Byull. Sov. Antarkt. Eksped., No. 46, 31-3(1964). 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Ice conditions in the Davis Strait between Greenland and E. Baffin Island were observed from January through April 1963. Changes in the ice formation are discussed. The shift in position of the edge of the ice drift is plotted. (L.C.L.)

14412 (UCRL-Trans-10155) DISPERSION OF ICEBERGS NORTH OF THE SHORES OF EASTERN ANTARCTICA OBSERVED DURING THE 1962-63 NAVIGATION SEASON. Eskin, L. I. Translated by Robert Addis for Univ. of California, Lawrence Radiation Lab., Livermore, from Inform. Byull. Sov. Antarkt. Eksped., No. 46, 34-6(1964). 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Iceberg observations in the Antarctic Ocean were carried out visually and with instruments by a seaborne research team during December 1962 and March and April of 1963. The boundaries of the maximal dispersion of Antarctic icebergs were determined and plotted. The transport of icebergs in the Antarctic Ocean is discussed. (L.C.L.)

14413 (UCRL-Trans-10196) ANALYTICAL METHOD FOR CALCULATING THE LOCATION PARAMETERS OF FLAT EJECTION CHARGES IN BUILDING ROCK DAMS. Baranov, E. G.; Gorin, Yu. N. Translated by T. Lazar for Univ. of California, Lawrence Radiation Lab., Livermore from Tr. Sess. Uch. Sov. Nar. Ispol'z. Vzryva, 5th, Frunze, Kirg. SSR, July 1963, 5: 286-96(1965). 25p. Dep. CFSTI. JCL $2.60 fs, $0.95 mf.

An analytical method is described for calculating the factors which influence the optimum placement of flat ejection explosive charges used in building rock dams. (L.C.L.)

14414 NONPROLIFERATION OF NUCLEAR WEAPONS. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-NINTH CONGRESS, SECOND SESSION ON S. RES. 179, FEBRUARY 23, AND MARCH 1, AND 7, 1966. Washington, D. C., Joint Committee on Atomic Energy, 1966. 82p. GPO $0.50.

14415 LOSS OF THE U.S.S. THRESHER. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-EIGHTH CONGRESS, FIRST AND SECOND SESSIONS, JUNE 26, 27, JULY 23, 1963,

AND JULY 1, 1964. Washington, D. C., Joint Committee on Atomic Energy, 1965. 202p. GPO $0.55.

14416 ARGONNE NATIONAL LABORATORY ANNUAL REPORT, 1966. Argonne, Ill., Argonne National Lab., 1966. Chicago, Univ. of Chicago, 1966. 120p. DTIE.

The experimental and theoretical investigations undertaken at ANL during 1966 are summarized. Topics include physical sciences, life sciences, reactor sciences, Argonne and the universities, and administrative, general, and technical services. (B.G.D.)

Appendix I

JOURNAL LIST

The following list includes 1968 additions to the comprehensive list published in NSA, Volume 22, No. 1, January 15, 1968. In the future, comprehensive lists will be published once each year (in January), and current additions will be cumulated on a monthly basis (in alternate issues) until the next comprehensive list is issued.

The title abbreviations are based on the United States of America Standards Institute's REVISED AND ENLARGED WORD-ABBREVIATION LIST FOR USASI Z39.5–1963 AMERICAN STANDARD FOR PERIODICAL TITLE ABBREVIATIONS. Titles of journals that are scanned regularly for NUCLEAR SCIENCE ABSTRACTS are marked by an asterisk (*). Foreign-language journals identified by a dagger (†) are available in English translation. The original-language title for a translated journal is given in parenthesis after the English title.

Acta Anat. Nippon.
Acta Anatomica Nipponica
see **Kaibogaku Zasshi**

Acta Astron.
Acta Astronomica, Polska Akademia Nauk (formed by merger of Acta Astronomica, Ser. A; Ser. B; and Ser. C) *(Poland)*

Acta Entomol. Bohemoslov.
Acta Entomologica Bohemoslovaca *(Czechoslovakia)*

Acta Med. Iugoslav.
Acta Medica Iugoslavica *(Yugoslavia)*

Acta Pharm. Hung.
Acta Pharmaceutica Hungarica *(Hungary)*

Acta Phys. Chem.
*Acta Physica et Chemica *(Hungary)*

Acta Polytech., Chem. Met. Ser.
Acta Polytechnica, Chemistry including Metallurgy Series *(Sweden)*

Acta Sci. Natur. Univ. Pekin.
Acta Scientiarum Naturalium Universitatis Pekinensis
see **Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh**

Advan. Contr. Syst.
Advances in Control Systems *(U. S.)*

Advan. Cryog. Eng.
Advances in Cryogenic Engineering *(U. S.)*

Advan. Nucl. Phys.
Advances in Nuclear Physics *(U. S.)*

Advan. X-Ray Anal.
Advances in X-Ray Analysis *(U. S.)*

Agr. Hokkaido
Agriculture in Hokkaido
see **Hokuno**

Agr. Res. (New Delhi)
Agricultural Research (New Delhi) *(India)*

Air Water Pollut.
*Air and Water Pollution (formerly International Journal of Air Water Pollution) *(U. S.–England)*

Ala. J. Med. Sci.
Alabama Journal of Medical Sciences, The *(U. S.)*

Ann. Bot. Fenn.
Annales Botanici Fennici *(Finland)*

Ann. Ponts Chaussees
Annales des Ponts et Chaussees *(France)*

Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Geol.
*Annales Universitatis Scientiarum Budapestinensis de Rolando Eotvos Nominatae, Sectio Geologica *(Hungary)*

An. Univ. Bucuresti, Ser. Stiint. Natur., Fiz.
Analele Universitatii Bucuresti, Seria Stiintele Naturii, Fizica *(Romania)*

Arch. Jap. Chir.
Archiv fuer Japanische Chirurgie
see **Nippon Geka Hokan**

Arch. Neer. Sci. Exactes Natur.
Archives Neerlandaises des Sciences Exactes et Naturelles *(Netherlands)*

ASM (Amer. Soc. Metals), Trans. Quart.
*ASM (American Society for Metals), Transactions Quarterly (formerly Transactions of the American Society for Metals) *(U. S.)*

Astrofizika
Astrofizika *(Armenian S.S.R.)*

Astrophys. Lett.
*Astrophysical Letters *(Scotland)*

At. Absorption Newslett.
Atomic Absorption Newsletter *(U. S.)*

At. Energy (China)
Atomic Energy (China)
see **Yuan Tzu Neng**

At. Energy Law J.
Atomic Energy Law Journal *(U. S.)*

Bautechnik
Bautechnik, Die *(West Germany)*

Berg- Huettenmaenn. Monatsh. Montan. Hochsch. Leoben
Berg- und Huettenmaennische Monatschefte der Montanistischen Hochschule in Leoben *(West Germany)*

Berlin. Wetterkarte, Suppl.
Berliner Wetterkarte, Supplement *(West Germany)*

Blech
Blech *(West Germany)*

Bodenkultur
Bodenkultur, Die *(Austria)*

Boll. Zool.
Bollettino di Zoologia. Pubblicato dall'Unione Zoologica Italiana *(Italy)*

Bull. Astron.
Bulletin Astronomique *(France)*

Bull. Belgicatom
Bulletin Belgicatom (formerly Belgicatom, Association Belge pour le Developpement Peficique de l'Energie Atomique, Bulletin d'Information) *(Belgium)*

Bull. Fac. Eng., Hiroshima Univ.
Bulletin of the Faculty of Engineering, Hiroshima University
see **Hiroshima Daigaku Kogakubu Kenkyu Hokoku**

Bull. Fac. Sci. Eng., Chuo Univ.
Bulletin of the Faculty of Science and Engineering, Chuo University
see **Chuo Daigaku Rikogakubu Kiyo**

Bull. Inst. Geophys., Nat. Cent. Univ.
*Bulletin of the Institute of Geophysics, National Central University *(China (Taiwan))*

Bull. Inst. Space Aeronaut. Sci., Univ. Tokyo
Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo
see **Tokyo Daigaku Uchu Koku Kenkyusho Hokoku**

Bull. Kyoto Educ. Univ., Ser. B
Bulletin of the Kyoto Educational University, Series B. Mathematics and Natural Science *(Japan)*

Bull. Res. Inst. Miner. Dressing Met., Tohoku Univ.
Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University
see **Tohoku Daigaku Sanko Seiren Kenkyusho Iho**

Bull. Soc. Roy. Bot. Belg.
Bulletin de la Societe Royale de Botanique de Belgique *(Belgium)*

Bus. Week
Business Week *(U. S.)*

Cah. Ing. Agron.

Cahiers des Ingenieurs Agronomes *(France)*

Calcified Tissue Res.
Calcified Tissue Research *(West Germany)*

Can. J. Psychol.
Canadian Journal of Psychology *(Canada)*

Can. Mach. Metalwork.
Canadian Machinery and Metalworking *(Canada)*

Can. Nurse
Canadian Nurse *(Canada)*

Cercet. Met.
Cercetari Metalurgice *(Romania)*

Chesapeake Sci.
Chesapeake Science *(U. S.)*

Chim. Ind., Genie Chim.
Chimie et Industrie, Genie Chimique (formed by the merger of Chimie et Industrie (Paris) and Genie Chimique (Paris)) *(France)*

Chin. Anim. Husb. Vet. Med.
Chinese Animal Husbandry and Veterinary Medicine
see Chung Kuo Hsu Mu Shou I

Chin. J. Surg.
Chinese Journal of Surgery
see Chung Hua Wai K'o Tsa Chih

Chung Hua I Hsueh Tsa Chih
Chung Hua I Hsueh Tsa Chih (National Medical Journal of China) *(China)*

Chung Hua Wai K'o Tsa Chih
Chung Hua Wai K'o Tsa Chih (Chinese Journal of Surgery) *(China)*

Chung Kuo Hsu Mu Shou I
Chung Kuo Hsu Mu Shou I (Chinese Animal Husbandry and Veterinary Medicine) *(China)*

Chuo Daigaku Rikogakubu Kiyo
Chuo Daigaku Rikogakubu Kiyo (Bulletin of the Faculty of Science and Engineering, Chuo University) *(Japan)*

Civil Eng. (N. Y.)
Civil Engineering (New York) *(U. S.)*

Coal Age
Coal Age *(U. S.)*

Cobalt
Cobalt *(France)*

Commer. Fish. Rev.
Commercial Fisheries Review *(U. S.)*

Comput. Biomed. Res.
Computers and Biomedical Research *(U. S.)*

Coord. Chem. Rev.
Coordination Chemistry Reviews *(Netherlands)*

Curr. Mod. Biol.
Currents in Modern Biology *(Netherlands)*

Denki Shikenjo Kenkyu Hokoku
Denki Shikenjo Kenkyu Hokoku (Researches of the Electrotechnical Laboratory) *(Japan)*

Desalination
Desalination *(Netherlands)*

Eiyo To Shokuryo
Eiyo To Shokuryo (Journal of Japanese Society of Food and Nutrition) *(Japan)*

Electron. Ind. (Paris).
Electronique Industrielle (Paris) *(France)*

Electron. Packag. Prod.
Electronic Packaging and Production *(U. S.)*

Elec. World
Electrical World *(U. S.)*

Elec. World (Shanghai)
Electrical World (Shanghai)
see Tien Shih Chieh

Elektromedizin
Elektromedizin und Ihre Grezgebiete *(Germany)*

Elektrotekhnika
Elektrotekhnika *(U.S.S.R.)*

Engei Gakkai Zasshi
Engei Gakkai Zasshi (Journal of the Japanese Society for Horticultural Science) *(Japan)*

Engl. Elec. J.
English Electric Journal *(England)*

Entropie
Entropie *(France)*

Ergonomics
Ergonomics *(England)*

Farm, Ranch, Home Quart.
Farm, Ranch and Home Quarterly *(U. S.)*

Fiz. Chastits Vys. Energ., Akad. Nauk Gruz. SSSR, Inst. Fiz.
Fizika Chastits Vysokikh Energii, Akademiya Nauk Gruzinskoi SSR, Institut Fiziki *(Georgian S.S.R.)*

Fiziol. Norm. Patol. (Bucharest)
Fiziologia Normala si Patologica (Bucharest) *(Romania)*

Fiz. Tekh. Poluprov.
*Fizika i Tekhnika Poluprovodnikov *(U.S.S.R.)*

Flame Notes, Beckman
Flame Notes, Beckman *(U. S.)*

Folia Haematol. (Leipzig)
Folia Haematologia (Leipzig) *(East Germany)*

Folia Med. Cracov.
Folia Medica Cracoviensia *(Poland)*

Forest. Abstr.
Forestry Abstracts *(England)*

Fortschr. Zool.
Fortschritte de Zoologie *(West Germany)*

Foundry
Foundry *(U. S.)*

Freiberg. Forschungsh., B
Freiberger Forschungshefte, Reihe B *(East Germany)*

Fukuoka Acta Med.
Fukuoka Acta Medica
see Fukuoka Igaku Zasshi

Fukuoka Igaku Zasshi
Fukuoka Igaku Zasshi (Fukuoka Acta Medica) *(Japan)*

Fukushima Daigaku Gakugei Gakubu Rika Hokoku
Fukushima Daigaku Gakugei Gakubu Rika Hokoku (The Science Reports of the Faculty of Arts and Science, Fukushima University) *(Japan)*

Geofys. Sb.
Geofysikalni Sbornik *(Czechoslovakia)*

Geol. Geofiz.
Geologiya i Geofizika *(U.S.S.R.)*

Haikan Gijutsu
Haikan Gijutsu (The Piping Engineering) *(Japan)*

Handb. Med. Radiol.
Handbuch der Medizinschen Radiologie *(West Germany)*

Harper Hosp. Bull.
Harper Hospital Bulletin *(U. S.)*

Health Lab. Sci.
Health Laboratory Science *(U. S.)*

Hemel Dampkring
Hemel en Dampkring *(Belgium)*

Hiroshima Daigaku Kogakubu Kenkyu Hokoku
Hiroshima Daigaku Kogakubu Kenkyu Hokoku (Bulletin of the Faculty of Engineering, Hiroshima University) *(Japan)*

Hoken Butsuri
Hoken Butsuri (Journal of Japan Health Physics Society) *(Japan)*

Hokuno
Hokuno (Agriculture in Hokkaido) *(Japan)*

Honvedorvos
Honvedorvos *(Hungary)*

Hyogo Noka Daigaku Kiyo
Hyogo Noka Daigaku Kiyo (Memoirs of the Hyogo University of Agriculture) *(Japan)*

Idengaku Zasshi, Suppl.
Idengaku Zasshi, Supplement (Japanese Journal of Genetics, Supplement) *(Japan)*

Indian J. Agr. Sci.
Indian Journal of Agricultural Science, The *(India)*

Indian J. Appl. Chem.
Indian Journal of Applied Chemistry *(India)*

Indian J. Cancer
Indian Journal of Cancer *(India)*

Indian J. Occup. Health
Indian Journal of Occupational Health *(India)*

Ind. Water Eng.
Industrial Water Engineering *(U. S.)*

Inform. Byull. Sov. Antarkt. Eksped.
Informatsionnyi Byulleten Sovetskoi Antarkticheskoi Ekspeditsii *(U.S.S.R.)*

Inst. Mining Met., Trans./Sect. B
Institution of Mining and Metallurgy, Transactions/Section B. Applied Earth Science (continues in part Transactions of the Institution of Mining and Metallurgy) *(England)*

Inst. Petrol. Rev.
Institute of Petroleum Review, The *(England)*

Int. Chem. Eng.
*International Chemical Engineering. A Quarterly Journal of Translations from Russia, Eastern Europe, and Asia *(U. S.)*

Int. J. Neurol.
International Journal of Neurology *(U. S.)*

Int. Rev. Gesam. Hydrobiol.
Internationale Revue der Gesamten Hydrobiologie *(East Germany)*

Int. Surg.
International Surgery *(U. S.)*

Inzh. Zh., Mekh. Tverd. Tela
Inzhenernyi Zhurnal, Mekhanika Tverdogo Tela (formerly

Inzhenernyi Zhurnal) *(U.S.S.R.)*

Izobret., Prom. Obraztsy, Tovarnye Znaki
Izobreteniya, Promyshlennye Obraztsy, Tovarnye Znaki *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Geol.
Izvestiya Akademii Nauk SSSR, Seriya Geologicheskaya *(U.S.S.R.)*

Jap. J. Genet., Suppl.
Japanese Journal of Genetics, Supplement
see Idengaku Zasshi, Suppl.

Jap. J. Pharm. Chem.
Japanese Journal of Pharmacy and Chemistry
see Yakugaku Kenkyu

Jap. J. Zootech. Sci.
Japanese Journal of Zootechnical Science
see Nippon Chikusangaku Kaiho

JARE Sci. Rep., Spec. Issue
JARE Scientific Reports, Special Issue *(Japan)*

J. Aust. Ceram. Soc.
Journal of the Australian Ceramic Society *(Australia)*

J. Balneol. Soc. Jap.
Journal of the Balneological Society of Japan
see Onsen Kagaku

J. Belge Radiol., Monogr.
*Journal Belge de Radiologie, Monographie *(Belgium)*

Jeune Sci.
Jeune Scientifique *(Canada)*

J. Forensic Med.
Journal of Forensic Medicine *(South Africa)*

Jibiinkoka Rinsho
Jibiinkoka Rinsho (Oto-Rhino-Laryngological Clinic) *(Japan)*

J. Indian Soc. Soil Sci.
Journal of the Indian Society of Soil Science *(India)*

J. Inst. Safety High Pressure Gas Eng.
Journal of the Inst. of Safety of High Pressure Gas Engineering
see Koatsu Gasu

J. Inst. Telecommun. Eng.
Journal of the Institution of Telecommunication Engineers *(India)*

J. Irrig. Drain. Div., Amer. Soc. Civil Eng.
Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers *(U. S.)*

J. Jap. Health Phys. Soc.
Journal of Japan Health Physics Society
see Hoken Butsuri

J. Jap. Soc. Food Nutr.
Journal of Japanese Society of Food and Nutrition
see Eiyo To Shokuryo

J. Jap. Soc. Hort. Sci.
Journal of the Japanese Society for Horticultural Science
see Engei Gakkai Zasshi

J. Jap. Tech. Ass. Pulp Pap. Ind.
Journal of the Japanese Technical Association of Pulp and Paper Industry
see Kami Pa Gikyoshi

J. Jap. Wood Res. Soc.
Journal of the Japan Wood Research Society
see Mokuzai Gakkaishi

J. Macromol. Sci., Part A
Journal of Macromolecular Science, Part A. Chemistry (supersedes Journal of Macromolecular Chemistry) *(U. S.)*

J. Nagasaki Med. Ass., Suppl.
Journal of the Nagasaki Medical Association, Supplement
see Nagasaki Igakkai Zasshi, Suppl.

J. Phys., A (London)
*Journal of Physics, A (London), Proceedings of the Physical Society (General) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., B (London)
*Journal of Physics, B (London), Proceedings of the Physical Society (Atomic and Molecular Physics) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., C (London)
*Journal of Physics, C (London), Proceedings of the Physical Society (Solid State Physics) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., E (London)
*Journal of Physics, E (London) (supersedes Journal of Scientific Instruments) *(England)*

J. Phys. Chem. Solids, Suppl.
*Journal of Physics and Chemistry of Solids, Supplement *(England)*

J. Radiol. Phys. Ther., Univ. Kanazawa
Journal of Radiology and Physical Therapy, University of Kanazawa, The
see Kanazawa Irigaku Sosho

J. Soc. Eng. Miner. Springs, Jap.
Journal of the Society of Engineers for Mineral Springs, Japan
see Onsen Kogakkaishi

J. Soc. Fiber Sci. Technol., Jap.
Journal of the Society of Fiber Science and Technology, Japan
see Sen'i Gakkaishi

J. Soc. Instr. Contr. Eng.
Journal of the Society of Instrument and Control Engineers
see Keisoku To Seigyo

J. Soc. Rubber Ind., Jap.
Journal of the Society of Rubber Industry, Japan
see Nippon Gomu Kyokaishi

Kagaku Keisatsu Kenkyusho Hokoku
Kagaku Keisatsu Kenkyusho Hokoku (Reports of the National Research Inst. of Police Science) *(Japan)*

Kagoshima Daigaku Suisangakubu Kiyo
Kagoshima Daigaku Suisangakubu Kiyo (Memoirs of the Faculty of Fisheries, Kagoshima University) *(Japan)*

Kaibogaku Zasshi
Kaibogaku Zasshi (Acta Anatomica Nipponica) *(Japan)*

Kami Pa Gikyoshi
Kami Pa Gikyoshi (Journal of the Japanese Technical Association of Pulp and Paper Industry) *(Japan)*

Kanazawa Irigaku Sosho
Kanazawa Irigaku Sosho (Journal of Radiology and Physical Therapy, University of Kanazawa, The) *(Japan)*

Keisoku To Seigyo
Keisoku To Seigyo (Journal of the Society of Instrument and Control Engineers) *(Japan)*

Klin. Monatsbl. Augenheilk.
Klinische Monatsblaetter fuer Augenheilkunde und fuer Augenaerztliche Fortbildung *(West Germany)*

Koatsu Gasu
Koatsu Gasu (Journal of the Inst. of Safety of High Pressure Gas Engineering) *(Japan)*

Kobe Kogyo Giho
Kobe Kogyo Giho (Kobe Kogyo Technical Report) *(Japan)*

Kobe Kogyo Tech. Rep.
Kobe Kogyo Technical Report
see Kobe Kogyo Giho

K'o Hsueh To Chung
K'o Hsueh To Chung (Popular Science) *(China)*

Kosm. Biol. Med.
Kosmicheskaya Biologiya i Meditsina *(U.S.S.R.)*

Kovove Mater.
Kovove Materialy *(Czechoslovakia)*

Kumamoto Daigaku Kogakubu Kenkyu Hokoku
Kumamoto Daigaku Kogakubu Kenkyu Hokoku (Technical Reports of the Kumamoto University) *(Japan)*

Kumamoto Daigaku Kyoikugakubu Kiyo
Kumamoto Daigaku Kyoikugakubu Kiyo (Memoirs of the Faculty of Education, Kumamoto University) *(Japan)*

Kurznachr. Akad. Wiss. Goettingen
Kurznachrichten der Akademie der Wissenschaften in Goettingen *(West Germany)*

Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku
Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku (Report of the Training Inst. for Engineering Teachers, Kyoto University) *(Japan)*

Kyushu Daigaku Kogaku Shuho
Kyushu Daigaku Kogaku Shuho (Technology Reports of the Kyushu University) *(Japan)*

Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku
Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku (The Reports of the Research Inst. of Science and Industry, Kyushu University) *(Japan)*

Landbouwtijdschrift
Landbouwtijdschrift *(Belgium)*

Lasers Opt. Non Conv.
Lasers et Optique Non Conventionelle *(France)*

Lebensversicherungsmedizin
Lebensversicherungsmedizin *(West Germany)*

Lipids
Lipids *(U. S.)*

Machinery (N. Y.)
Machinery (New York) *(U. S.)*

Mach. Prod. Eng.
Machinery and Production Engineering *(England)*

Mach. Shop Eng. Mfg.
Machine Shop and Engineering Manufacture *(England)*

Mach. Tool Blue Book
Machine and Tool Blue Book *(U. S.)*

Mag. Stand.
Magazine of Standards *(U. S.)*

Mass Prod.
Mass Production *(England)*

Mater. Res. Bull.
Materials Research Bulletin *(U. S.)*

Mem. Fac. Educ., Kumamoto Univ.
Memoirs of the Faculty of Education, Kumamoto University
see Kumamoto Daigaku Kyoikugakubu Kiyo

Mem. Fac. Fish., Kagoshima Univ.
Memoirs of the Faculty of Fisheries, Kagoshima University
see Kagoshima Daigaku Suisangakubu Kiyo

Mem. Hyogo Univ. Agr.
Memoirs of the Hyogo University of Agriculture
see Hyogo Noka Daigaku Kiyo

Meres Automat.
Meres es Automatika *(Hungary)*

Mes., Regul., Automat.
Mesures, Regulation, Automatisme *(France)*

Metabolism
*Metabolism: Clinical and Experimental *(U. S.)*

Metallwirtschaft
Metallwirtschaft–Wissenschaft–Technik *(Germany)*

Metals Abstr.
*Metals Abstracts (successor to Review of Metal Literature and Metallurgical Abstracts) *(U. S.-England)*

Metal Sci. Heat Treat. (USSR) (Engl. Transl.)
Metal Science and Heat Treatment (USSR) (English Translation of Metallovedenie i Termicheskaya Obrabotka Metallov) *(U. S.)*

Met. Rev. (Publ. in Metals Mater.)
Metallurgical Reviews (Published in Metals and Materials) *(England)*

Microwaves
Microwaves *(U. S.)*

Mod. Packag.
Modern Packaging *(U. S.)*

Mokuzai Gakkaishi
Mokuzai Gakkaishi (Journal of the Japan Wood Research Society) *(Japan)*

Mol. Biol.
*Molekulyarnaya Biologiya *(U.S.S.R.)*

Monit. Zool. Ital., Suppl.
Monitore Zoologico Italiano, Supplemento *(Italy)*

Montes
Montes *(Spain)*

Motortech. Z.
Motortechnische Zeitschrift *(West Germany)*

Nachrichtentechnik
Nachrichtentechnik *(East Germany)*

Nagasaki Igakkai Zasshi, Suppl.
Nagasaki Igakkai Zasshi, Supplement (Journal of the Nagasaki Medical Association, Supplement) *(Japan)*

Nat. Fire Codes
National Fire Codes *(U. S.)*

Nat. Med. J. China
National Medical Journal of China
see Chung Hua I Hsueh Tsa Chih

Nauch. Zap. Inst. Mashinoved. Avtomat., Akad. Nauk Ukr. SSR, Ser. Mashinoved.
Nauchnye Zapiski Instituta Mashinovedeniya i Avtomatiki, Akademiya Nauk Ukraninskoi SSR, Seriya Mashinovedeniya *(Ukrainian S.S.R.)*

Neth. J. Sea Res.
Netherlands Journal of Sea Research *(Netherlands)*

Neues Jahrb. Mineral., Monatsh.
Neues Jahrbuch fuer Mineralogie, Monatshefte *(West Germany)*

Nippon Byori Gakkai Kaishi
Nippon Byori Gakkai Kaishi (Transactiones Societatis Pathologicae Japonicae) *(Japan)*

Nippon Chikusangaku Kaiho
Nippon Chikusangaku Kaiho (Japanese Journal of Zootechnical Science) *(Japan)*

Nippon Geka Hokan
Nippon Geka Hokan (Archiv fuer Japanische Chirurgie) *(Japan)*

Nippon Gomu Kyokaishi
Nippon Gomu Kyokaishi (Journal of the Society of Rubber Industry, Japan) *(Japan)*

Nippon Sakumotsu Gakkai Kiji
Nippon Sakumotsu Gakkai Kiji (Proceedings of the Crop Science Society of Japan) *(Japan)*

Nisshin Seiko Giho
Nisshin Seiko Giho (Technical Report of Nisshin Steel Co., Ltd.) *(Japan)*

Norsk Skogind.
Norsk Skogindustri *(Norway)*

N. Z. Sci. Rev.
New Zealand Science Review *(New Zealand)*

Oceanogr. Mag.
Oceanographical Magazine, The *(Japan)*

Okayama Daigaku Onsen Kenkyusho Hokoku
Okayama Daigaku Onsen Kenkyusho Hokoku (Papers of the Inst. for Thermal Spring Research, Okayama University) *(Japan)*

Onde Elec., Suppl.
*Onde Electrique, L, Supplement *(France)*

Onsen Kagaku
Onsen Kagaku (Journal of the Balneological Society of Japan) *(Japan)*

Onsen Kogakkaishi
Onsen Kogakkaishi (Journal of the Society of Engineers for Mineral Springs, Japan) *(Japan)*

Opt.-Mekh. Prom.
Optiko-Mekhanicheskaya Promyshlennost *(U.S.S.R.)*

Osaka Furitsu Kogyo Shoreikan Hokoku
Osaka Furitsu Kogyo Shoreikan Hokoku (Reports of Industrial Research Inst., Osaka Prefecture) *(Japan)*

Oto-Rhino-Laryngol. Clin.
Oto-Rhino-Laryngological Clinic
see Jibiinkoka Rinsho

Pap. Inst. Thermal Spring Res., Okayama Univ.
Papers of the Inst. for Thermal Spring Research, Okayama University
see Okayama Daigaku Onsen Kenkyusho Hokoku

Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (Acta Scientiarum Naturalium Universitatis Pekinensis) *(China)*

Phys.-Diaet. Ther.
Physikalisch-Diaetetische Therapie *(West Germany)*

Phys. Earth Planet. Interiors
*Physics of the Earth and Planetary Interiors *(Netherlands)*

Piping Eng.
Piping Engineering, The
see Haiken Gijutsu

Plant Breed. Abstr.
*Plant Breeding Abstracts *(England)*

Plant Cell Physiol. (Kyoto)
Plant and Cell Physiology (Kyoto) *(Japan)*

Poluprov. Prib. Ikh Primen., Sb. Statei
Poluprovodnikovye Pribory i Ikh Primenenie, Sbornik Statei *(U.S.S.R.)*

Pop. Sci. (Peking)
Popular Science (Peking)
see K'o Hsueh Tu Chung

Poznan. Tow. Przyj. Nauk, Wydz. Lek., Pr. Kom. Farm.
Poznanskie Towarzystwo Przyjaciol Nauk, Wydzial Lekarski, Prace Komisji Farmaceutycznej *(Poland)*

Praxis (Bern)
Praxis (Bern) *(Switzerland)*

Probl. Fiziol. Opt.
Problemy Fiziologicheskoi Optiki *(U.S.S.R.)*

Proc. Amer. Soc. Hort. Sci.
Proceedings of the American Society for Horticultural Science *(U. S.)*

Proc. Crop Sci. Soc. Jap.
Proceedings of the Crop Science Society of Japan
see Nippon Sakumotsu Gakkai Kiji

Proc. Indian Acad. Sci., Sect. B
Proceedings of the Indian Academy of Sciences, Section B *(India)*

Proc. La. Acad. Sci.
*Proceedings of the Louisiana Academy of Sciences, The *(U. S.)*

Proc. Nat. Acad. Sci., India, Sect. A
Proceedings of the National Academy of Sciences, India, Section A *(India)*

Proc. Phys. Soc. (London)
Proceedings of the Physical Society (London) changed to Journal of Physics, A, B, and C *(England)*

Proc. Soc. Water Treat. Exam.
Proceedings of the Society for Water Treatment and Examination *(England)*

Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.)
*Proceedings (Trudy) of the P. N. Lebedev Physics Institute (USSR) (English Translation of Trudy Fizicheskogo Instituta imeni P. N. Lebedeva, Akademiya Nauk SSSR) *(U. S.)*

Progr. Ind. Microbiol.
Progress in Industrial Microbiology *(U. S.–England)*

Progr. Solid State Chem.
Progress in Solid State Chemistry *(England)*

Queensland Govt. Mining J.
Queensland Government Mining Journal *(Australia)*

Radiobiol. Biol. Mol.
Radiobiologia si Biologia Moleculara *(Romania)*

Radioprotection
Radioprotection. Bulletin de la Societe Francaise de

Radioprotection *(France)*

Rad. Poljopr. Fak. Univ. Sarajevu
Radovi Poljoprivrednog Fakulteta Univerziteta u Sarajevu *(Yugoslavia)*

Reactor Fuel-Process. Technol.
*Reactor and Fuel-Processing Technology (A Quarterly Technical Progress Review) (formerly Power Reactor Technology and Reactor Fuel Processing) *(U. S.)*

Rec. Trav. Bot. Neer.
Recueil des Travaux Botaniques Neerlandais *(Netherlands)*

Rep. Fac. Sci., Shizuoka Univ.
Reports of Faculty of Science, Shizuoka University *(Japan)*

Rep. Fire Res. Inst. Jap.
Report of Fire Research Inst. of Japan
see ***Shobo Kenkyusho Hokoku***

Rep. Ind. Res. Inst., Osaka Prefect.
Reports of Industrial Research Inst., Osaka Prefecture
see ***Osaka Furitsu Kogyo Shoreikan Hokoku***

Rep. Nat. Res. Inst. Police Sci.
Reports of the National Research Inst. of Police Science
see ***Kagaku Keisatsu Kenkyusho Hokoku***

Rep. Res. Inst. Ind. Safety
Reports of the Research Inst. of Industrial Safety
see ***Sangyo Anzen Kenkyusho Hokoku***

Rep. Res. Inst. Sci. Ind., Kyushu Univ.
Reports of the Research Inst. of Science and Industry, Kyushu University
see ***Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku***

Rep. Tokyo-to Lab. Med. Sci.
Report of Tokyo-to Lab. for Medical Sciences
see ***Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku***

Rep. Train. Inst. Eng. Teach., Kyoto Univ.
Report of the Training Inst. for Engineering Teachers, Kyoto University
see ***Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku***

Res. Electrotech. Lab.
Researches of the Electrotechnical Laboratory
see ***Denki Shikenjo Kenkyu Hokoku***

Rev. Acad. Cienc. Exactas, Fis.-Quim. Natur. Zaragoza
Revista de la Academia de Ciencias Exactas, Fisico-Quimicas y Naturales de Zaragoza *(Spain)*

Rev. Brazil. Quim. (Sao Paulo)
*Revista Brasileria de Quimica *(Brazil)*

Rev. Elec.
Revista Electricidade *(Portugal)*

Rev. Fr. Elec.
*Revue Francaise de l'Electricite *(France)*

Rev. Interamer. Radiol.
Revista Interamericana de Radiologia *(Peru)*

Rev. Roum. Sci. Tech., Ser. Mecan. Appl.
Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee *(Romania)*

Rev. Zootch. Med. Vet.
Revista de Zootehnic si Medicina Veterinara *(Romania)*

Roy. Observ. Bull.
Royal Observatory Bulletins *(England)*

Roy. Soc. Health J.
Royal Society of Health Journal *(England)*

RUM, Rev. Universelle Mines
RUM, Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l'Industrie (formerly Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l'Industrie) *(Belgium)*

S. Afr. Mech. Eng.
South African Mechanical Engineer, The *(South Africa)*

Samoletostr. Tekh. Vozdush. Flota
Samoletostroenie i Tekhnika Vozdushnogo Flota *(U.S.S.R.)*

Sangyo Anzen Kenkyusho Hokoku
Sangyo Anzen Kenkyusho Hokoku (Reports of the Research Inst. of Industrial Safety) *(Japan)*

Scand. J. Clin. Lab. Invest., Suppl.
Scandinavian Journal of Clinical and Laboratory Investigation, Supplement *(Sweden)*

Sci. Ind. Spatiales
Sciences et Industries Spatiales *(Switzerland)*

Sci. News (Wash., D. C.)
Science News (Washington, D. C.) *(U. S.)*

Sci. Proc. Roy. Dublin Soc., Ser. A
Scientific Proceedings of the Royal Dublin Society, The, Series A (supersedes The Scientific Proceedings of the Royal Dublin Society, New Series) *(Ireland)*

Sci. Rep., Coll. Gen. Educ., Osaka Univ.
Science Report, College of General Education, Osaka University *(Japan)*

Sci. Rep. Niigata Univ., Ser. B
Science Reports of Niigata University, Series B. Physics *(Japan)*

Scr. Met.
Scripta Metallurgica *(U. S.)*

Seminars Hematol.
*Seminars in Hematology *(U. S.)*

Seminars Roentgenol.
Seminars in Roentgenology *(U. S.)*

Sen'i Gakkaishi
Sen'i Gakkaishi (Journal of the Society of Fiber Science and Technology, Japan) *(Japan)*

Ser. Haematol.
Series Haematologica (Supplements Scandinavia Journal of Haematology) *(Denmark)*

Sheet Metal Ind.
Sheet Metal Industries *(England)*

Shobo Kenkyusho Hokoku
Shobo Kenkyusho Hokoku (Report of Fire Research Inst. of Japan) *(Japan)*

Showa Densen Denran Rebyu
Showa Densen Denran Rebyu (Showa Wire and Cable Review) *(Japan)*

Showa Wire Cable Rev.
Showa Wire and Cable Review
see ***Showa Densen Denran Rebyu***

Slaboproudy Obz.
Slaboproudy Obzor *(Czechoslovakia)*

Soc. Petrol. Eng. J.
Society of Petroleum Engineers Journal, The *(U. S.)*

Sov. Antarct. Exped. Inform. Bull.
Soviet Antarctic Expedition Information Bulletin (English Translation of Informatsionnyi Byulleten Sovetskoi Antarkticheskoi Ekspeditsii) *(U. S.)*

Strain
Strain *(England)*

Stud. Cercet. Endocrinol.
Studii si Cercetari de Endocrinologie *(Romania)*

Stud. Cercet. Energ. Electrotch.
Studii si Cercetari de Energetica si Electrotehnica *(Romania)*

Svetsaren Engl.
Svetsaren in English *(Sweden)*

Tech. Dig. (Prague)
Technical Digest (Prague), Statni Nakladatelstvi Technicke Literatury *(Czechoslovakia)*

Technol. Rep. Kyushu Univ.
Technology Reports of the Kyushu University
see ***Kyushu Daigaku Kogaku Shuho***

Tech. Rep. ISSP (Inst. Solid State Phys.), Ser. A
Technical Report of ISSP (Inst. for Solid State Physics), Series A *(Japan)*

Tech. Rep. Kumamoto Univ.
Technical Reports of the Kumamoto University
see ***Kumamoto Daigaku Kogakubu Kenkyu Hokoku***

Tech. Rep. Nisshin Steel Co., Ltd.
Technical Report of Nisshin Steel Co., Ltd.
see ***Nisshin Seiko Giho***

Terapia (Milan)
Terapia (Milan) *(Italy)*

Terapia (Turin)
Terapia (Turin) *(Italy)*

Tien Shih Chieh
Tien Shih Chieh (Electrical World) *(China)*

Tohoku Daigaku Senko Seiren Kenkyusho Iho
Tohoku Daigaku Senko Seiren Kenkyusho Iho (Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University) *(Japan)*

Tokyo Daigaku Uchu Koku Kenkyusho Hokoku
Tokyo Daigaku Uchu Kenkyusho Hokoku (Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo) *(Japan)*

Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku
Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku (Report of Tokyo-to Lab. for Medical Sciences) *(Japan)*

Trans. Amer. Ophthalmol. Soc.
Transactions of the American Ophthalmological Society *(Canada)*

Trans. Indian Ceram. Soc.
Tranactions of the Indian Ceramic Society *(India)*

Transp. Stroit.
Transportnoe Stroitel'stvo *(U.S.S.R.)*

Trans. Soc. Instrum. Contr. Eng.
Transactions of the Society of Instrument and Control Engineers *(Japan)*

Trans. Soc. Pathol. Jap.
Transactiones Societatis Pathologicae Japonicae

see Nippon Byori Gakkai Kaishi

Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial
Trudy Instituta Biologii, Akademiya Nauk SSSR, Ural'skii Filial *(U.S.S.R.)*

Tr., Mosk. Aviats. Tekhnol. Inst.
Trudy, Moskovskii Aviatsionnyi Tekhnologicheskii Institut *(U.S.S.R.)*

Tr. Mosk. Vet. Akad.
Trudy Moskovskoi Veterinarnoi Akademii *(U.S.S.R.)*

Tumor Res.
Tumor Research *(Japan)*

T Z Prakt. Metallbearb.
T Z fuer Praktische Metallbearbeitung *(West Germany)*

Vector (Baltimore)
Vector (Baltimore) *(U. S.)*

Vestn. Cesk. Spolecnosti Zool.
Vestnik Ceskoslovenske Spolecnosti Zoologicke *(Czechoslovakia)*

Vestn. Mosk. Univ., Ser. IV. Geol.
Vestnik Moskovskogo Universiteta, Seriya IV. Geologiya *(U.S.S.R.)*

Vodosnabzh. Sanit. Tekh.
Vodosnabzhenie i Sanitarnaya Tekhnika *(U.S.S.R.)*

Volt, Elec. Trade Mon.
Volt, Electrical Trade Monthly *(Japan)*

Vop. Eksp. Klin. Radiol., Khar'kov. Inst. Med. Radiol.
Voprosy Eksperimental'noi i Klinicheskoi Radiologii, Khar'kovskii Institut Meditsinskoi Radiologii *(Ukrainian S.S.R.)*

Water Res.
Water Research (supersedes in part Air and Water Pollution) *(England)*

Water Waste Treat.
Water and Waste Treatment *(England)*

Weld. Res. Counc. Bull.
Welding Research Council Bulletin *(U. S.)*

Wien. Z. Inn. Med. Grenzgeb.
Wiener Zeitschrift fuer Innere Medizin und ihre Grenzgebiete *(Austria)*

Wiss. Z. Ernst-Moritz-Arndt-Univ. Greifswald, Math.-Naturwiss. Reihe
Wissenschaftliche Zeitschrift der Ernst-Moritz-Arndt-Universitaet Greifswald, Mathematisch-Naturwissenschaftliche Reihe *(East Germany)*

Yadern. Priborostr., Nauch.-Tekh. Sb.
Yadernoe Priborostroenie, Nauchno-Tekhnicheskii Sbornik *(U.S.S.R.)*

Yakugaku Kenkyu
Yakugaku Kenkyu (Japanese Journal of Pharmacy and Chemistry) *(Japan)*

Yuan Tzu Neng
Yuan Tzu Neng (Atomic Energy) *(China)*

Z. Math. Phys.
Zeitschrift fuer Mathematik und Physik *(East Germany)*

Z. Mikrosk.-Anat. Forsch.
Zeitschrift fuer Mikroskopisch-Anatomische Forschung (Abt. 2 of Jahrbuch fuer Morphologie und Mikroskopische Anatomie) *(East Germany)*

Z. Phys. Chem. B
Zeitschrift fuer Physikalische Chemie. Abt. B *(Germany)*

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